36th ONTARIO WASTE MANAGEMENT CONFERENCE

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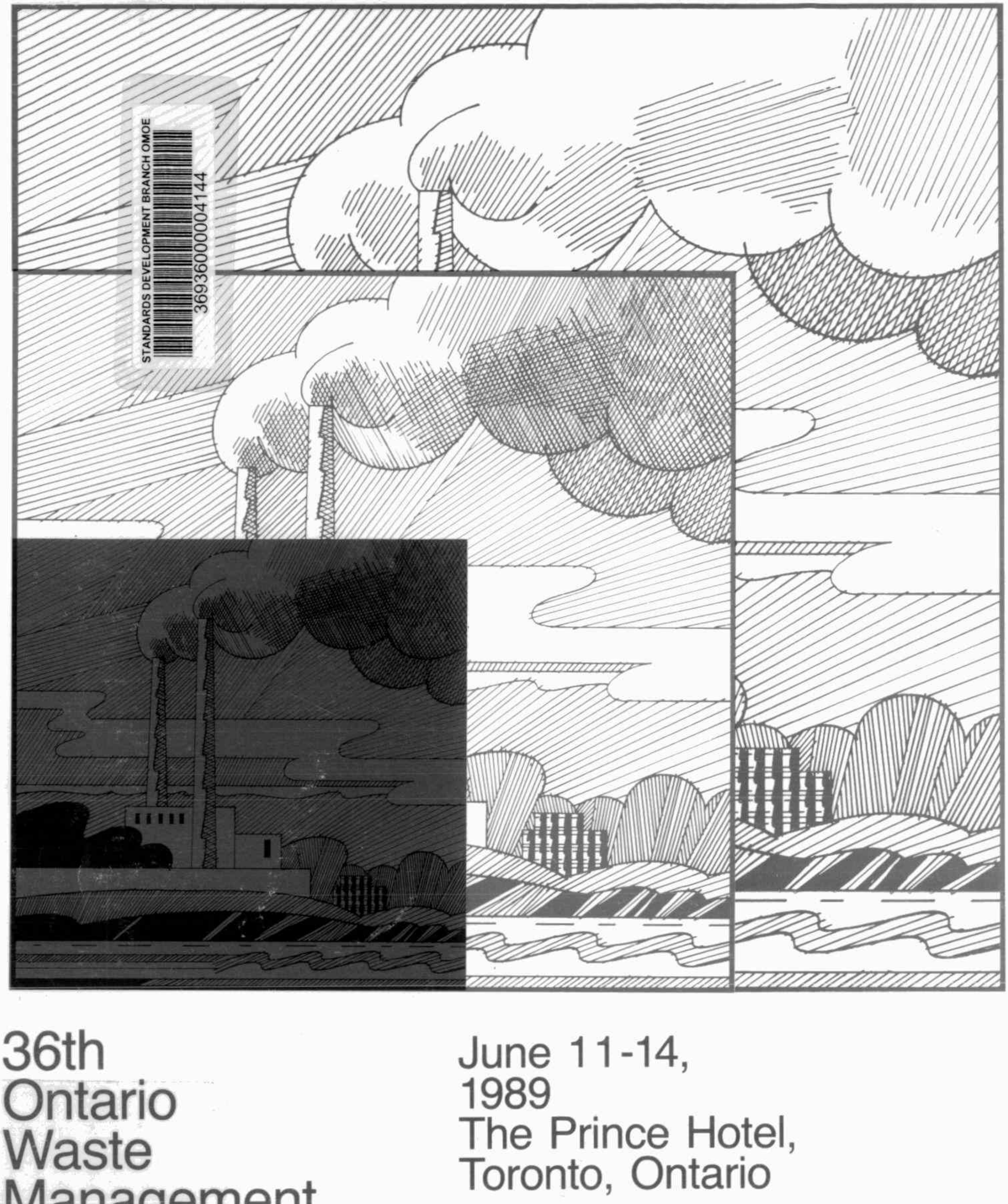

36th
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ceedings

June 11-14,
1989
The Prince Hotel,
Toronto, Ontario

Environment
Ontario

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Proceedings
# of the
Thirty-sixth
Ontario Waste Management Conference

held at

The Prince Hotel
Toronto, Ontario

June 11-14, 1989

Sponsored by the
Ontario Ministry of the Environment

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PREFACE TO THE PROCEEDINGS
OF THE
36th ONTARIO WASTE MANAGEMENT CONFERENCE

On behalf of the Ministry of the Environment, and the Conference Planning and Program Committees, our thanks and appreciation to all those who registered for the annual Ontario Waste Management Conference. Attendance was 415 for the 1989 session.

The consensus of those present was that this year's format, with the additional papers and extended sessions, offered delegates an extra opportunity to gain insight into topics that expanded on the overall conference theme of the management of waste. Our discussions and exchanges confirm that the decade of the 80's has seen recognition of the holistic approach to environmental concerns, and these concerns are going to continue into the 90's and the 21st century.

There is no question that we had a successful information exchange, thanks to the authors and the session moderators, all of whom contributed significantly to the success of the program. As Conference Chairman, it was gratifying to work with the members of the Planning and Program Committees whose organizational efforts helped to continue the reputation we have achieved from previous years. The contribution of Program Committee representatives from the Pollution Control Association of Ontario and the Air and Waste Management Association was especially helpful and appreciated.

The papers contained in the following Proceedings are those presented at the Conference. It is your permament record of our deliberations. Share it with your associates and encourage their attendance at the 1990 Waste Management Conference, the 37th, to be held at the Prince Hotel in Toronto, June 10 to 13th inclusive. Plan to attend.

Boris Boyko,
Chairman

ONTARIO WASTE MANAGEMENT CONFERENCE
HISTORICAL DATA

Location	**Dates**	**Sponsor**
Ontario Agriculture College, Guelph	1954 to 1956	Pollution Control Board of Ontario
Delawana Inn, Honey Harbour	1957 to 1963	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Bigwin Inn, Lake of Bays	1964 & 1965	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Park Motor Hotel, Niagara Falls	1966 & 1967	Ontario Water Resources Commission
Sheraton Brock Hotel, Niagara Falls	1968 to 1971	Ontario Water Resources Commission
Skyline Hotel, Toronto	1972 to 1974	Ontario Ministry of the Environment
The Prince Hotel, Toronto	1975 to 1989	Ontario Ministry of the Environment

Conference Chairman	**Dates**	**Secretary/ Co-Ordinator**
Dr. A.E. Berry	1954 to 1962	D.S. Caverly/M. Grove
D.S. Caverly	1963 to 1973	L.M. Tobias
K.H. Sharpe	1974 to 1976	M.J. Cathcart (1974)
D.P. Caplice	1977 & 1978	
	1975 to 1989	M.F. Cheetham
J.W. Giles	1979 to 1986	
R.M. Gotts	1987	
B.I. Boyko	1988 & 1989	

Program Conveners

1954-1959	A.V. DeLaporte
1960-1973	F.A. Voege
1974-1978	J.B. Patterson
1979-1989	R.C. Stewart

1990 – 37th ONTARIO WASTE MANAGEMENT CONFERENCE
THE PRINCE HOTEL, TORONTO, ONTARIO
JUNE 10-13

CONFERENCE PLANNING COMMITTEE

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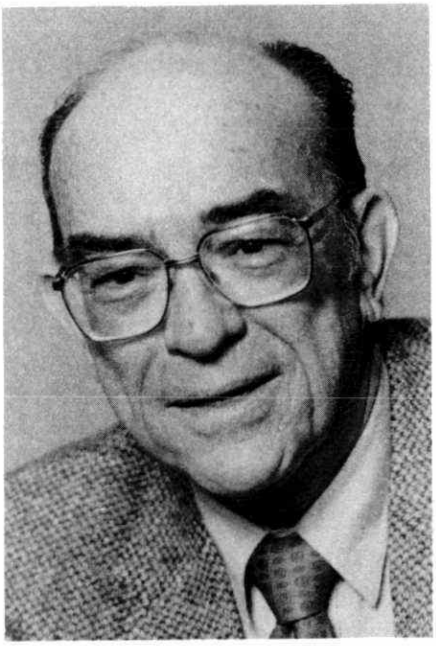
B.I. Boyko
Director,
West Central Region,
Ontario Ministry of the
Environment

Conference Vice-Chairman
H.M. Wong,
Director,
Waste Management Branch,
Ontario Ministry of the
Environment

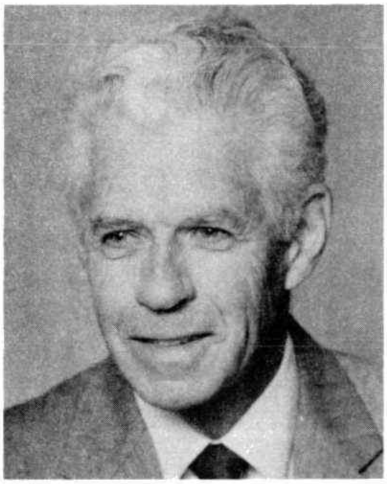
Program Convener
R.C. Stewart,
Manager Technical Support,
West Central Region,
Ontario Ministry of the
Environment



Conference Co-Ordinator
M.F. Cheetham,
Co-Ordinator, Freedom of
Information and Privacy Protection,
Ontario Ministry of the
Environment

TECHNICAL PROGRAM COMMITTEE

C.E. Duncan, Coordinator,
Niagara River Improvement
Program, Environment Ontario
Hamilton



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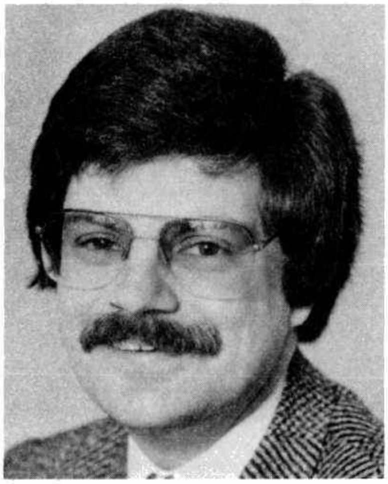
Southwestern Region,
Environment Ontario, London

P. Isles, Manager,
MISA Office, Industrial Sector
Water Resources Branch,
Environment Ontario



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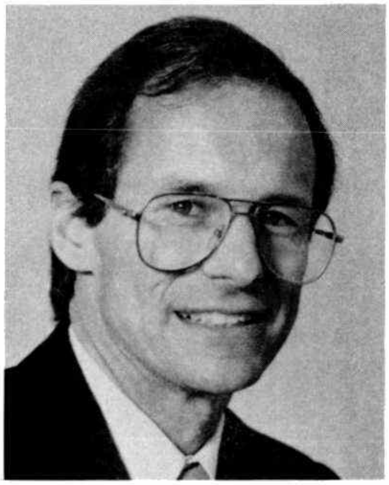
Section, Waste Management Branch,
Environment Ontario



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Dofasco, Hamilton,
for Pollution Control Association of
Ontario

S. Toplack, Region of Niagara
Works Dept., Thorold, Ontario
for Air and Waste Management
Association

THE PAPERS AND THE AUTHORS

at the

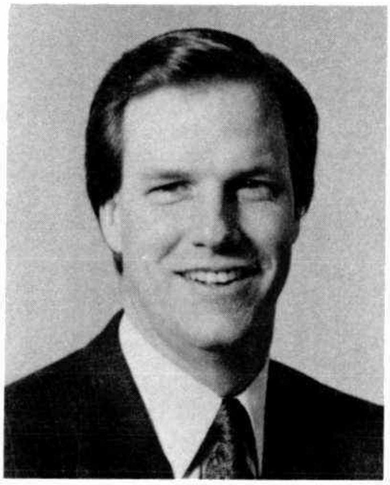
36th ONTARIO WASTE MANAGEMENT CONFERENCE

JUNE 1989

TORONTO, ONTARIO

SESSION I – ENVIRONMENTAL OVERVIEW

Moderator: Dr. D.A. Chant
Chairman and President, Ontario
Waste Management Corporation
Toronto, Ontario



Carman McClelland, MPP
Parliamentary Assistant to the
Ontario Minister of the
Environment, Toronto

H.M. Wong, Director
Waste Management Branch
Environment Ontario, Toronto

G. Patterson, Vice-Chairman
Environmental Assessment Board
Toronto, Ontario

Dr. D. Mackay, Department of
Chemical Engineering
University of Toronto
Toronto, Ontario

D.S. Saxe
Legal Services Branch
Environment Ontario

MINISTRY UPDATE AND NEW INITIATIVES

by

Carman McClelland, MPP, Brampton North
Parliamentary Assistant to the Minister
of the Environment, Toronto, Ontario

It is a pleasure to join you here today at this thirty-sixth annual waste conference and share in the give and take that has been established over so many years.

Environment Minister Jim Bradley is meeting his colleagues in the Canadian Council of Resource and Environment Ministers today. On his behalf, I am pleased to participate in this exchange.

This annual event is one of the finest traditions maintained by professional staff in the Ministry of the Environment. It provides a forum for innovation and an exchange for the best ideas from those professionals in the public and private sector who have chosen to dedicate their careers to reducing pollution and protecting our environment.

As the agenda shows, we will cover a wide range of issues, each relating to the challenge we face in coping with the impact of our society's wastes on their discharge to the environment.

You will hear how Quebec is coping with damage in the wake of the St-Basile-le-Grande fire, and some of the legal implications of acquiring environmentally damaged property. There will be much said on controlling and containing wastes, whether the discharge vehicle is a chimney, a sewer outfall or a truck.

Still other presentations and panels will deal with the provincial, national and even global impact of these waste materials.

Over the past four years, our government has directed the environment ministry toward a methodical and comprehensive approach to protecting our environment.

Our drinking water surveillance program provides comprehensive and regular testing of the products of our water treatment facilities. The Municipal Industrial Strategy for Abatement -- MISA -- and the binational Remedial Action Programs -- or RAPS --provide frameworks both for reducing ongoing pollution and cleaning up historical contamination.

Our Air Quality Index network and other monitoring provides the information needed to alert us to air pollution problems. With Countdown Acid Rain and new regulations governing chlorofluorocarbons, we are addressing the long-range transport issue and our Clean Air Program -- CAP -- will apply the MISA approach to air pollution.

As all of these programs advance, solid waste management remains as a frontier for innovation and I will focus my remarks on this subject today.

Bear in mind the sheer magnitude of waste production in Ontario. Every year, we produce enough garbage -- in household waste alone -- to fill a line of garbage trucks stretching from Windsor to Whitehorse. Add the commercial and light industrial waste that also goes to our landfills and incinerators, and our line of garbage trucks must double park over that distance.

The traditional waste disposal methods of burning or burying our garbage are inadequate, imprudent and wasteful.

The necessity of dealing safely with industrial and household wastes, the wasteful tradition of throwing away useful materials even though they are made from finite resources and local opposition to landfill and waste treatment facilities, has focused substantial public concern and government attention on waste management issues.

As a society we have the garbage habit. All of us -- every man, woman and child -- throw away 16 times our weight in garbage every year. The world's resource base cannot continue to sustain this rate of one-time consumption followed by disposal in a hole in the ground or a furnace.

We are a province rich in minerals, but there is a fixed amount of iron ore and aluminum in the ground. When they are gone, they are gone. The same for the petroleum deposits that are the base material for our fuels, our plastics and thousands of chemicals on which our society has become dependent. There are limits even to the rate that we can use paper. Trees cannot be considered a renewable resource when we use them up faster than we replant and grow their replacements.

This is why Ontario's waste management policies and programs place the first priority on 4R solutions.

One of the most visible and popular of these programs is Blue Box curbside multi-material recycling. The Ministry's funding for recycling has increased from three-quarters of a million dollars four years ago to seven point seven million last year. This is supplemented by assistance from the soft drink industry which established Ontario Multi-Material Recycling Inc. -- OMMRI for short -- as its vehicle to fund, promote and encourage recycling. Our Recycling Advisory Committee brings together industry, the environmental community and municipalities to advise and assist me in developing and promoting recycling programs. Together we have literally made "recycling" a household word in Ontario.

Four years ago, there were only three Blue Box recycling communities with 40,000 households being served in Ontario. The program had stalled for lack of political will, with not one new household served in over a year. Now 1.4 million Ontario households in more than 130 communities are serviced by Blue Boxes. In the next few years, we expect to be providing three million Ontario households with Blue Box service -- and have rural depots available for nearly everyone else.

Just over a month ago, stressing the importance of environmental initiatives, Ontario's Speech from the Throne noted a new emphasis on environmental education. A key part of this is our new STAR program or Student Action for Recycling.

This hands-on recycling education program is in the pilot project phase at 16 schools. In these schools, students and staff are working out the best ways of operating an effective institutional recycling project. They are collecting fine paper, newspaper, cans and bottles in Blue Boxes in each classroom, cafeteria and staff room.

The lessons we learn from these pilot projects will be applied as we phase-in STAR provincewide starting this September. We hope to have every school in a Blue Box community recycling within three years.

In March, the Minister announced Ontario's plan to go into a new era for the 4Rs. This is a major element in the comprehensive Ontario waste reduction strategy featured in the Speech from the Throne.

The challenge is to make Ontario an environmentally sustainable society. Our first priority is to simply reduce wasteful consumption, and to make products more durable or design them to be re-used. By 1992, we aim to divert 25 per cent of solid waste -- both household and commercial/industrial -- from landfill and incineration back into the production process through reduction, recycling and re-use. By the year 2000, we intend to see at least half of this waste diverted.

About a week after Mr. Bradley announced these targets on March 10, he and Quebec's Environment Minister Lise Bacon met in Montreal with environment ministers from across Canada. They managed to get full agreement to make the 50 per cent diversion target by 2000 a national goal.

While Ontario and Quebec were already committed to this goal, we welcomed the acceptance nationally of a common target. Consistency and uniformity of objectives and policies on a national scale will reduce the risk that different standards and restrictions could impede our progress.

In addition, it opens the door for broader industrial involvement on a national scale, similar to the effort put forth through OMMRI, by Ontario's soft drink industry.

Ontario is now expanding municipal recycling projects. Additional household recyclables, such as mixed plastics, boxboard, and corrugated cardboard are being phased-in in some jurisdictions. Metro Toronto has recently added plastic bottles and corrugated cardboard collection to its Blue Box projects, and I congratulate Metro recyclers for this progressive initiative.

Recycling service must also be extended to apartment dwellers. The City of Guelph is Ontario's leader in this area. New communities will continue to start Blue Box projects.

Ontario's municipal Blue Box recycling program has already benefited from strong financial and technical support from the soft drink industry via OMMRI. The establishment of an expanded industry-based structure to flow private sector funding into the 4Rs is essential for the kind of dramatic expansion we are planning.

OMMRI's base of experience as veterans of recycling will be especially useful as we bring in new industrial sectors to assume their fair share of responsibility.

The Ministry of the Environment has already launched consultation with key industrial sectors. We are meeting separately with newspaper publishers, plastics industry representatives, grocery products manufacturers, grocery distributors and retailers, and the packaging industry.

At this stage, we are discussing the degree of commitment and funding appropriate to each of these sectors. Within the next few weeks, I hope we can bring them all together for a consensus meeting. Out of this, I expect a new, broader-based industry organization to coalesce.

Our role, at this stage, is to act as a catalyst to bring this group together as an industry-driven operation, working with, but apart from, government, as OMMRI has been.

If necessary, our government is prepared to impose regulations which will ensure participation by all relevant industries, to make sure they take responsibility for the environmental fate of their products.

While we have accelerated the growth of recycling dramatically in the past four years, you are going to see even more exciting developments in Ontario as these new industries take up their responsibilities.

Composting will be a new factor for the householder and the municipality.

Organic wastes make up one-third of total household waste volumes. The province is committed to contributing to a program to help provide home composting units to householders who want one, and to aid municipalities in setting up collection systems and communal composting facilities. Pilot projects will be launched later this year, and will be followed by a provincewide effort.

Additionally, municipalities will be aided in diverting autumn leaves and Christmas trees from landfill. The leaves will be composted and the trees chipped for use on parkland pathways.

The private sector, as a whole, must do much more to reduce the wastes it generates. The opportunities are virtually unlimited.

Key sectors will be expected to develop 4R programs with provincial help and direction. These include office towers with their wealth of fine paper, construction companies which generate wood and wallboard waste, commercial plazas which are a rich source of corrugated cardboard, food wholesalers and retailers which generate corrugated cardboard and organic waste, and fast food outlets that produce packaging and organic wastes.

Regulations will be introduced where voluntary measures do not achieve desired results.

While the private sector is expected to assume responsibility for these efforts, the province is also committed financially to such 4R efforts. We expect to invest as much as 80 million dollars by the year 2000 in support of private sector initiatives.

Beyond this aid, we are providing incentives and initiatives to encourage action and involvement.

Our industrial 4Rs program has already stimulated innovation and generated new ideas which will further divert waste from disposal. To date we have committed more than seven million dollars to more than 100 projects to reduce waste generation, divert waste from disposal and develop new uses and recycling methods for waste materials.

These include:

- Recovery of both plastics and metals from used electrical cable.
- Recovery of metals such as copper, chromium and nickel from small and large-scale electroplating operations.
- Developing a new type of collection vehicle and providing ongoing assistance for processing and baling cardboard and other papers from commercial sources.
- Demonstrating a new process to recover high-grade protein and lactose from whey wastes.

We would like to see more proposals that deal with hazardous wastes, offering some promising 4R approaches to ensure that these are put to productive use rather than being discharged into the environment.

Most projects submitted have concentrated on reuse, recycling and recovery of wastes. I hope that more people will bring forth ideas on process changes that could reduce the generation of waste materials.

We intend to introduce legislation clarifying the province's power to make 4R activities mandatory. It will then be possible to insist that particular recyclable materials be removed from the waste stream prior to landfilling or incineration.

We also intend to urge all municipalities to charge a true-cost tipping fee for waste received at treatment and disposal facilities, and to use the money to establish a reserve fund. The charges should reflect the full operating and replacement costs of waste management facilities.

This approach has the benefit of encouraging waste generators to employ 4R measures to reduce waste quantities headed for disposal.

I see this sort of fund placing waste management, including the development of new disposal facilities, on a self-sustaining financial footing. More importantly, it would promote the development of 4R activities by establishing a level economic playing field for 4R options to compete fairly with disposal.

We know that from society's point-of-view, disposal is more expensive than the 4R alternatives, and I believe that this environmental truth ought to be reflected in dollars and cents.

Our Research Advisory Committee will provide government assistance to research and develop new and innovative 4R technologies and markets. These funds are expected to total $50 million by the year 2000.

Trained Environment Ministry staff will offer telephone assistance on technical matters such as interpretation of regulations, funding programs, technology data sources from around the world, and names and addresses of operators of similar facilities or programs. The hotline will be initiated in 1990 and will become a hub of information-sharing on 4R issues.

Ministry technical staff, trained in waste reduction and recycling technologies, will be available to visit plants and municipalities to offer on-the-spot information and recommendations. They will discuss proven methods and provide detailed information. This team of technical advisors will be available to municipalities, industry and the commercial sector by 1991.

Government and private sector efforts to achieve effective 4R programs, the need to improve management of landfills and incinerators, and the environmental assessment of major municipal waste management facilities create a demand for better consulting, better engineering and better operations.

In summary, we have higher expectations in all aspects of environmental protection and a real need for the best professional service.

The current environment, for people like you, whose careers are based on your expertise, is one of unparalleled opportunity. More than ever before, you have an open invitation to show what you can do, on behalf of public and private sector decision makers.

You can also make a real difference in terms of a better and more sustainable environment for the people of this province.

WASTE MANAGEMENT PAST AND PRESENT

by

H. M. Wong, Director, Waste Management
Branch, Environment Ontario, Toronto

Mr. Wong spoke from notes and did not have a prepared text for his presentation. His comments were an expansion and adjunct to the initiatives related in the previous paper. Should additional details or comments be desired, please contact the author direct.

DRASTIC ACTION NEEDED TO PROTECT CANADA'S WATER RESOURCES

by

Dr. D. Mackay, Department of
Chemical Engineering, University
of Toronto, Toronto, Ontario

Dr. Mackay spoke from notes and did not have a formal text of his paper. His comments were based on an article he prepared and which was published in the February 1989 issue of Environmental Science & Engineering. With permission of the publishers, that article is reproduced following.

Many challenges currently face those who provide water supply and disposal in Canada today. Perhaps most difficult of all, is the issue of the large number of toxic contaminants which are present in natural waters and are thus inevitably present in drinking water.

Perhaps we can best address this issue by examining four aspects. First, the *identification of the nature and severity of the problem*, second some *jurisdictional and legal aspects*, then our *present scientific and engineering knowledge of causes and effects*, and finally whether or not there is the *political will* to pay for the remedies.

Identifying the Issue

The news media bombard the public with a continual stream of bad news about toxic chemicals. Much of this news is drawn from the numerous scientific reports which discuss toxic chemicals in water and recommend various remedial actions. Resulting public pressures caused the Federal government to enact the Canadian Environmental Protection Act, and in Ontario the Municipal-Industrial Strategy for Abatement (MISA) program which is now well underway. These programs have not yet reduced contamination levels. It is likely that it will be some years before this occurs, because the initial phases will tend to be data gathering, deciding what should be done and who should pay, rather than actually accomplishing reductions in levels of toxic substances. But the direction is clear. The public is demanding, and will get, a cleaner water environment.

The 3Ds

Ontario has published its list of *Effluent Monitoring Priority Pollutants* which has about 180 chemicals which are believed to be present in Ontario's water, are regarded as being sufficiently toxic to be of concern and so are candidates for monitoring and control. It is likely that even more chemicals will be added to this list as analytical methods improve and new information flows into the system.

Perhaps there are three properties (the three Ds) of chemicals which cause concern. First are chemicals which are *Distributive* or bioconcentrate. For example, PCBs at a concentration of 1 nanogram (10^{-9} g) per litre (ng/L) in water may be able to concentrate in fish and achieve levels of about 1 milligram per kilogram (or ppm) which is a concentration increase by a factor of 1 million. Because of this extreme *Distributive* property, one mouthful of fish can contain the equivalent of a million mouthfuls of water thus providing a vehicle for unusually high human exposure.

Second, are chemicals which are *Directive* or which influence the future growth patterns of organisms. Most chemicals are toxic if taken in sufficient quantities. That toxicity is often caused merely by the disruptive nature of the burden of chemical in the organism. To humans 50 g of alcohol is quite disruptive and 200 g may be fatal. A more insidious problem is caused by chemicals, which in very tiny amounts, are able to affect the organism, not by disrupting it directly, but by directing its growth patterns down undesired pathways. These include carcinogens, mutagens and teratogens.

By analogy, a fly weighing 1 milligram impacting a jumbo jet weighing 500 tonnes has very little effect on the jet - but the same mass of blood clot lodging in precisely the wrong place in the pilot's brain at a critical moment could result in disaster. This is not because of the mass of the clot but because it is able to *direct* a sequence of events which ultimately leads to disaster.

Finally, is the *Durability* or persistence of chemicals. Like humans and other animals, chemicals have a distinct lifetime in the environment which is dictated by their reactivity in the air, water, soil and sediments and especially their susceptibility to biodegradation. Many chemicals such as organic ligneous material of natural origin, PCBs, DDT are very durable. They will survive in the environment for many years. They can build up high concentrations and undertake long environmental journeys permitting them to impact organisms which are some distance from the source. Short-lived chemicals tend to be less of a problem because they are limited to locations close to the discharge point and are unable to build up high concentrations.

Of particular and growing concern are the organochlorine compounds, that is chemicals containing the carbon-chlorine bond. Such compounds are not believed to be produced naturally thus enzymes possess only a limited capability of degrading them. Many of the chemicals on the Ontario list are organochlorines. There is a widely held belief that we should organize a chemical lifestyle to avoid producing, using and discharging such chemicals because of their durability, and in many cases their toxicity.

Chemicals such as PCBs or DDT which possess distributive, directive and durable properties are thus critical environmental contaminants. In large measure the Ontario MISA program is being directed to controlling emissions of these chemicals from sources such as the chemical and pulp and paper industries. As challenging, will be the problem of controlling the emission of such chemicals from homes and light industry into sewers, and thus into natural waters.

The Incomprehensibility of Tinyness

Most environmental regulatory agencies were organized into groups handling chemicals which are classified as air pollutants, agricultural chemicals, water pollutants, etc. It is now clear that this categorization is no longer appropriate. All chemicals have, at least to some extent, the potential to migrate into all media such as air, water, soil and sediment and thus impact humans by inhalation of air, drinking water, eating food, vegetation, meat and fish. It is often not clear which exposure route is dominant. We must also face the reality that it is no longer credible to state that there is *no* dioxin in water. Compounds such as the dioxins are present in all these media, although the concentrations may be well below current analytical detection levels.

We must educate the public to accept the fact that it will never be possible to completely eliminate all toxic chemicals from drinking water. If none are found in drinking water it is merely because the analytical instruments used were not sufficiently expensive.

A fundamental problem in this educational task is that the public and indeed many engineers and scientists, have an inadequate understanding of the concentration units used in reporting levels of toxic chemicals. A concentration of 20 micrograms/litre means little to the average member of the public and probably sounds twice as bad as 10 milligrams/litre despite the fact that it is 500 times lower. We are now dealing with concentrations in the range of nanograms or picograms or femtograms per litre. Even scientists have difficulty remembering what these prefices mean. This problem of *the incomprehensibility of tinyness* raises severe difficulties. When can we ever communicate the concentrations in units that will enlighten and satisfy a sceptical public?

Intolerance

The public has apparently a strong and growing inherent intolerance, or instinctive dislike, for contaminated air, water and food. How else can one explain the practice of buying bottled water at 40 cents per litre when water of as good quality is available at a cost of 40 cents per thousand litres from the tap? Almost every village has its health food store selling chemical-free, natural organically-grown foods. I have a theory that this distrust of contamination has deep instinctive origins.

Many animals test whether or not to eat material by smell. Their very survival depends on successfully discriminating between poisonous and non-poisonous food. As any wine connosieur knows our senses of taste and smell are closely linked. It may be that to ensure survival we have evolved a strong instinctive desire to select and eat only clean, uncontaminated food. Any food which smells, or looks contaminated produces a strong emotional reaction. Is this the cause of the bizarre and deeply entrenched dislikes of some children for some foods such as spinach or broccoli? When you crack open a rotten egg the response is immediate! We may thus be dealing with an instinctive reaction, not just obstinate intolerance.

This may explain in part why the public feels intensely uncomfortable about drinking water which has been drawn from lakes or rivers which are known to be contaminated, and whose fish exhibit abberations such as high incidences of tumours. Protestations that the water has been treated very thoroughly or that the concentration of compound X is only one part per billion are unlikely to resolve this concern. The concern may be illogical but it is certainly real. Real concern results in real political action. Witness the growing intolerance of smoking!

A simple test of tolerance to contamination is to take a group of people and ask them what level of cleanliness they would expect in a consumer product such as grated cheese. The Health Protection Branch of National Health and Welfare has guidelines which specifies the amount of insect fragments, dead mites, rodent hairs and metal pieces which may be found in samples of grated cheese. Most people would be horrified to learn that there could be any amount of any of these contaminants in purchased grated cheese. Table 1 shows that significant amounts are "acceptable", at least to food inspectors. How many people have died by eating insect fragments, mites or metal pieces in recent years? This is not really a health problem. It is a perception problem.

We must recognize that the public's attitude to drinking water is linked intimately to the perception of the contamination of the lake from which it is drawn. The perception may be highly emotional, but it is certainly real. I suggest that the obvious remedy is to decontaminate rivers and lakes back to the level at which ecosystems thrive, free from unusual incidences of abberations such as tumours. Only when the public can see organisms, preferably the charismatic ones with big brown eyes, thriving and drinking directly from the lake, can there be full assurance that treated drinking water drawn from that lake will be safe and acceptable.

Jurisdictional Issues

Some environmental issues such as the indoor pollution problem, suffer from lack of jurisdictional attention in that nobody wants to accept responsibility. If we examine some of the jurisdictional actors who are responsible for controlling the contamination in the region of Lake Ontario, we find a very different picture.

There is the Ontario Ministry of Environment and the Federal Department of the Environment which control emissions into the lake. The Department of Fisheries and Oceans worries about its fish, as does the Ontario Ministry of Natural Resources. On the US side are the EPA and the New York State Department of Environmental Conservation. At the International level is the International Joint Commission whose Water Quality Board alone has 31 committees deliberating about the state of the water. National Health and Welfare becomes concerned when the water is drunk, the Department of Transport and the Canadian Coast Guard become active when you float on it; the Department of Public Works is continually rearranging (dredging) the sediments and harbours, as is the US Army Corps of Engineers. Municipalities and industry draw water from the lakes, consultants study it and produce glossy reports. Universities study it and produce generally incomprehensible scientific reports. Environmental non-governmental organizations (ENGOs) protest about it, the International Association of Great Lakes Research researches it, groups such as this are concerned about it. Harbour and seaway commissions have important interests. No doubt there are many others.

I suggest we are suffering from jurisdictional overkill or *paralysis by analysis*. It is almost impossible for any one of these organizations to take any action without consulting several of the others, forming interdepartmental committees and entering into prolonged negotiations. Communication is often poor, at times reluctant, and occasionally hostile.

We must find a way out of this bureaucratic log jam. The only hope is strong political leadership backed by a vociferous demanding public.

Science, Knowledge, Technology and Understanding

In the last ten years considerable progress has been made in understanding the way in which toxic chemicals enter lakes and migrate between water, sediments and the atmosphere. *Figure 1* gives an example of the way in which PCBs are believed to have moved throughout the Lake Ontario environment in the last ten years. It is a tremendous intellectual challenge to understand the processes and deduce amounts subject to each process. Mass Balance diagrams such as Figure I are very difficult to assemble. It requires years of patient work but I am convinced that unless we understand the basic pathways of toxic chemicals we will never be able to regulate or control them properly.

By analogy, the chief executive officer of a large corporation must have an intimate understanding of the cash-flow throughout her organization -- where the money comes from, where it goes, the relative profitability of the various sectors. Only when she has this understanding can she properly direct the organization down more profitable paths. The same principle applies to toxic chemicals. Yet we are trying to manage toxic chemicals without understanding their *cash-flows*. This is an immense problem because there is a multitude of lakes and a multitude of toxic chemicals, and a miniscule amount of effort being devoted to understanding how the two interact.

There is a tremendous enthusiasm within the Ontario scientific community to undertake studies of this type. The only substantial funding for environmental work is now from the Ontario Ministry of the Environment. Yet in its recent awards, it could fund only 11.9% of the proposals submitted. The new proposals funded in the area of water amounted to only $239,000. The Federal government scrapped its Inland Water's Directorate research program and now has no peer reviewed funding program for water research by Canadian universities. Report after report has demonstrated the need for more science, but this falls on deaf ears in Ottawa. Not only are universities starved of research funds, but they are unable to provide educational research opportunities for graduate students wishing to devote their scientific or engineering careers to the solution of water pollution problems.

It is important to emphasize that while we lack understanding of the effects of toxic chemicals, it is now abundantly clear what the immediate actions should be. Too often, lack of scientific knowledge is used as an excuse for inaction, especially in the acid rain issue. Scientists will never admit that they understand a problem sufficiently. There is always more to be discovered. I am told that consultants have rubber stamps which state "Recommendation 1. Further study is needed". It is clear that there is one, and only one, road to decontamination - it is to reduce the loadings or kilograms per day of toxic chemicals into the Great Lakes. Once the chemicals are in the lakes nothing can be done about them. Loading reduction is thus the thrust of the enlightened MISA program.

Recent studies have shown that (i) if loadings are reduced by half then the level of contamination of the Great Lakes will be approximately reduced by half, and (ii) that lakes will respond very rapidly to these loading reductions, often within a year or two. Even for Lake Superior, in which water resides for some 185 years, a reduction in loading will often produce a reduction in water concentration within a couple of years. This is because most chemicals leave the water, not only by outflow, but also by sedimentation, volatilization or reaction. This is very good news and suggests that if we can act in a concerted way to reduce loadings, the Great Lakes may be restored relatively rapidly to a state of cleanliness, just as the Thames recovered very rapidly when Londoners finally decided after centuries of abuse to clean up their river. Remedial actions are thus obvious and need not be delayed for lack of science. Science will play a critical role in deciding when we have reached a state of virtual elimination, i.e. how clean is clean enough?

It is a tragic comment on the state of environmental science that we do not yet have one fully validated mass balance statement for one toxic chemical in one of the Great Lakes.

Political Will and Money

The costs of remediating or decontaminating our water resources are going to be substantial. Maintenance and improvement of urban infrastructure will be expensive. Sewage treatment plants must be upgraded, industrial discharges controlled and comprehensive programs of monitoring and scientific investigation put in place. But all we find is bickering between the various levels of government as to who is going to pay.

It is interesting to contrast this intolerable water situation with that of electricity. In Scarborough Ontario, a city of nearly half a million, in 1986 each residential customer consumed 317 cubic metres of water at 43 cents per cubic metre, costing a total of $136. The amount spent on electricity was $560 - four times greater. One could argue that efforts directed to water resources should be at least a quarter of those devoted to electricity supply. Ontario Hydro is a large, dynamic organization which conducts annually about $80 million worth of research, finances mega projects such as Pickering and Darlington and announces with little fanfare that it will spend $500 million retubing reactors. There is acceptance that the consumer pays the full price for electricity, including provision of new services, upgrading of existing services and research into new technologies. In short, the user pays.

In contrast, the provision of drinking water, maintenance of infrastructure, treatment of wastes and control of contamination of rivers and lakes is badly fragmented, financially starved and research has virtu-

ally ceased. Surely average customers would be willing to pay some surcharge on water bills if they could be assured that funds were to be used for the improvement of water resources and for scientific research. Regrettably there is no present mechanism by which this can be done.

Interestingly, any suggestion that electricity be provided to a home but not metered would be met with derision. Yet we persist in supplying many consumers with unmetered water. We have to seek a better mechanism whereby the full costs of maintaining Canada's water resources, providing drinking water and treating sewage are more adequately funded. I hope that part of this will be a complementary program of scientific research.

Again, this needs political leadership. Bitching by municipalities and scientists has become a tiresome burden, which most politicians have learned to accept and ignore.

Some Conclusions

We face a challenging task of stewardship of Canada's water resources. Contamination by toxic chemicals is only one of the issues, but it is a crucial one which we have addressed ineffectively. It is clear that the public has a strong aversion to contaminated water, that we need to clean up the raw water resource, and manage it more carefully. There is clearly a changing public attitude in the direction of increased intolerance of contamination. We must respond.

What then are the impediments to progress? I have suggested three. *First is the problem of jurisdictional overkill*, in which bureaucracies have proliferated to the extent that the taxpayer is no longer served by a lean, responsive organization, but instead is met by frustration, delays and interjurisdictional squabbles. *Second, there is inadequate support of science and engineering*, which are ultimately the only methods by which water can be decontaminated. No amount of reports, lawsuits or committee meetings will result in cleaner water. There must be pragmatic engineering measures and public education to reduce loadings of toxic chemicals. *Third, is the problem of funding*. I am not suggesting that we create a water analog to Ontario Hydro but we must adopt some of the principles which enable Ontario Hydro to be successful, far sighted and responsive. We must seek a mechanism by which the user is able to pay directly for improved service.

So what can be done? We have to break out of this deadlock of bureaucratic squabbling, scientific bitching and poverty-pleading. It can only be done if there is political leadership, and strong public support for that leadership. There are signs of this political leadership in Ontario. The status and impact of the Ontario Ministry of Environment has risen remarkably under the leadership of **Jim Bradley**. We have to send a clear signal to the politicians, such as Mr. Bradley, that the present situation is intolerable; that they must break the present deadlock, and that they will have our full support in efforts to decontaminate our lakes and rivers. Then we might enter into a new and more enlightened era of stewardship of our precious water resources.

Table 1: Excerpt from Extraneous Material Guidelines that Relate to the Safety and Cleanliness of Food. (Health Protection Branch, Ottawa) for a 225 g sample of grated cheese.

	n	c	m	M
Insect fragments (not mites)	3	1	4	8
Mites (dead)	3	1	25	34
Rodent hairs	3	1	1	3
Other Mammalian hair (not human)	3	1	1	3
Human hair	3	0	0	0
Rigid metal pieces 0.1 - 1.0 mm	3	1	8	16
Rigid metal pieces 1.0 - 2.0 mm	3	1	1	3
Rigid metal pieces >2.0 mm	3	0	0	0

Explanation:

n	number of samples to be taken
c	maximum number of marginally acceptable samples
m	acceptable amount
M	marginally acceptable amount

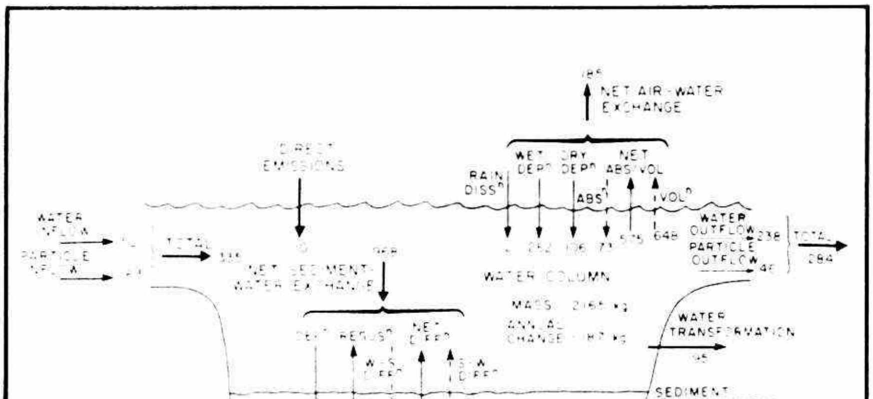


Figure 1: An estimated mass balance diagram for PCBs in Lake Ontario about 1985 in units of kilograms per year.

WASTE MANAGEMENT IMPLICATIONS IN REAL ESTATE TRANSACTIONS

by

D. S. Saxe, formerly with the Legal Services Branch, Ministry of the Environment, Toronto

The author's paper did not arrive in time to include it in normal numerical sequence before going into production.

The text of the paper follows the Delegate listing commencing on Page 313.

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THE ENVIRONMENTAL ASSESSMENT BOARD: PROCEDURES AND EXPECTATIONS

by

Grace Patterson, Vice-Chairman, The
Environmental Assessment Board, Ministry
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It is a pleasure to be speaking to you this morning. I'm sure that many of you have been involved in Environmental Assessment Board hearings or have participated in the preparation for hearings, and therefore have an interest in the Board's work.

The emphasis of my comments will concern the changes in the Board's mandate and workload. Also, I would like to deal with the Board's efforts to streamline its hearing and decision-making functions while maintaining fairness and accessibility.

As most of you will know, the Environmental Assessment Board is an agency of the Provincial Government. Its function is to conduct public hearings and make decisions in connection with proposed developments. The EAB draws its authority from 3 principal provincial laws and the nature of the project before the Board determines which legislation governs the hearing.

The Board holds public hearings pursuant to the Environmental Protection Act, the Ontario Water Resources Act, and the Environmental Assessment Act.
When a proposed development may require approval under more than one Act, involving several hearings, a proponent can apply for a single hearing under the Consolidated Hearings Act.

The Consolidated Hearings Act provides for the establishment of a Joint Board made up of members of either or both the Environmental Assessment Board and the Ontario Municipal Board. The Joint Board is then empowered to hold one hearing and consider all of the matters that could be considered at any of the hearings required by any of the 12 statutes set out in a schedule to the Act. The Joint Board then renders a decision with respect to those matters. At the present time all of the statutes over which the Environmental Assessment Board has jurisdiction and the principal statutes over which the Ontario Municipal Board has jurisdiction are included.

The purpose of the Environmental Assessment Act is stated to be "the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management in Ontario of the environment". So the Environmental Assessment Board has a broad mandate under the Act where environment is defined to include not only the natural environment but the manmade environment and the relationship between the two.

The Board's mandate is broadly defined but its deliberations are centered on the evidence before it, dealing with one project and its impacts. However, the Board does have the opportunity to assess each project within the context of general and specific environmental concerns and provincial policies and guidelines.

In the past the major emphasis of the Board's work was on hearings under the Environmental Protection Act and the Ontario Water Resources Act. Hearings under both of these acts were numerous, since all water or sewage works which were proposed to cross municipal boundaries required hearings in accordance with the OWRA. All waste management systems and most landfill sites required hearings under Part V of the EPA. Landfills and waste management projects still require hearings, but amendments to both pieces of legislation have changed the Board's role substantially. First, hearings involving municipal boundary crossings are no longer mandatory unless the proposal is controversial. Secondly, the Board is empowered to make decisions rather than providing recommendations to the Director of Approvals. The Board has also been given a cost award power.

These changes to the Board's powers have changed the nature of the workload and the type of document which is released to the public as a result of a particular hearing. Prior to the legislative changes, which occurred in June of 1988, the Board was required to summarize the evidence and the representations made to it during a hearing in a report to the Director of Approvals. Prior to issuing its report, the panel which heard the evidence was required to present its report to the rest of the Board for its consideration. This procedure contemplated changes by other members of the Board. It also contemplated changes by the Director to the recommended disposition of the application itself or to the terms and conditions attached to any approval.

Now that the Board makes decisions under the EPA and the OWRA, the practice with respect to conditions imposed with an approval has changed. It is now much more important that the parties deal with the substance and wording of conditions during the hearing itself, since the Director of Approvals can no longer add to or change the conditions recommended by the Board. The Board now prescribes the conditions which are to appear in certificates of approval.

In addition to the normal project-specific hearings, the Board deals with policy issues and projects of provincial interest. Examples of these are: the inquiry conducted by a Commission comprising three Board members into the proposed regulation to govern the use of mobile PCB destruction units in the province; the Class Environmental Assessment of Timber Management policies proposed by the Ministry of Natural Resources; and the proposed provincial facility for the management and disposal of hazardous waste.

The EAB and Joint Boards have the opportunity to interpret the Environmental Assessment Act, our most challenging piece of legislation, as it relates to specific applications. Our decisions try to offer some direction and assistance to future proponents and other participants in the environmental assessment approvals process.

For example, the Board, in its decisions, has consistently held that the environmental assessment must identify the need for a project, saying that if need cannot be shown it may not be in the public interest to allow a project to proceed.

The Board has held that the proponent must identify and assess reasonable alternatives to the undertaking, in compliance with the Act. However, even though the Board expects essential compliance with the Act it will not necessarily deny approval because the proponent has failed to assess a particular alternative put forward by a party in opposition. The test is one of reasonableness.

At the present time, the Environmental Assessment Act applies to all public sector proposals for undertakings unless excluded by an exemption order by the Minister or by regulation. Private sector proposals are drawn under the aegis of the Act only if they are specifically designated by regulation.

In March 1988, the Minister of the Environment indicated that all new proposals, public or private, for landfilling and/or incineration of municipal waste would be subject to the provisions of the Act.

The Petro-Sun/SNC application, an energy from waste proposal by a private sector proponent in the Region of Peel, was the subject of a Joint Board hearing last year. In its decision, the Joint Board expressed its views that the EAA could and should be applied in a consistent manner to both public and private sector proposals. The private sector would, of necessity and quite properly, assess the project and possible alternatives in the light of its economic well being and business mandate. However, the possible impacts on the environment would have to be as rigorously examined in a private sector proposal as in a public sector proposal.

After more than a decade of experience with the EAA process, issues continue to arise about its effectiveness and efficiency. Specifically the length and complexity of the approvals process is of concern to proponents, intervenors, government and the Board. The cost of the process in time and money may have already reached the point where only well-financed parties can participate.

Recently, a Joint Board rendered its decision on the Region of Halton's landfill site application. The preparation of the environmental assessment took five years and the Joint Board hearing lasted for 194 days during the period from May 5, 1987 to November 8, 1988. The Board published its decision on February 24, 1989.

The Hamilton Spectator, in an editorial of March 1, 1989, said:

> "Halton's ordeal confirms the importance of streamlining the environmental assessment rules to permit evidence to be presented in a much more concise, practical and inexpensive fashion. Were 50,000 pages of evidence really necessary to settle what proved to be a clear cut choice in the end?"

It is difficult to answer the Spectator's question regarding the specific application. We have the Board's decision to turn to in that respect.

However, the Spectator's sentiments echo those of many protagonists in the environmental assessment process, including the EAB itself.

Partly in response to complaints that the environmental assessment process is too time consuming, expensive and inefficient, the Ministry of the Environment in early 1988 announced its Environmental Assessment Program Improvement Project (EAPIP).

The government task force assigned to EAPIP is conducting a comprehensive review of the environmental assessment legislation and the organization and resources of the Ministry to deal with the process.

The Board has made recommendations to the EAPIP Task Force, having as its objective an increase in effectiveness and efficiency while maintaining the objectives of the Act. It also wants to maintain accessibility to its process and fairness in its proceedings.

The Board's comments to the task force to date have included recommendations that:

- the Ministry's EA Review Coordinator's role should be clarified and strengthened.
- more and clearer guidance should be given to proponents about what is expected of them.
- presubmission consultation should be mandatory for proponents and intervenors. The public should be consulted early and often during the planning process so that concerns can be resolved or the project changed to eliminate the concern.
- projects should be monitored when they are completed and in operation, not only for environmental impacts but to verify predictions made during the approvals process.
- the hearings should focus on issues of concern (not on every detail included in the written material).

The Board recognizes that fairness and accessibility can only be maintained if the cost of participation is not prohibitive. Therefore, it has also undertaken measures to streamline its procedures.

In January, 1988, the Board, after receiving input from interested parties, published a comprehensive set of rules of practice and procedure to enable those appearing before it to better understand the hearing process and to be aware of what was expected of them. Shortly thereafter the Board published a Citizen's Guide, which attempts to explain in laymen's terms the Board's hearing procedures.

As well, over the past year, various panels of the Board and Joint Boards have undertaken a number of procedural initiatives designed to speed up the hearing process. Examples of these procedures include:

1. requirements for the prefiling of reports and witness statements, which are to contain executive summaries,

2. meetings of experts in like disciplines from the various parties to discuss areas of agreement and disagreement,

3. requirements for parties to file statements of agreement on facts, issues or evidence,

4. prior submission of the order of testimony, list of experts and estimated time for examination-in-chief, and

5. confining the cross-examination of witnesses by parties of like interest to questions of clarification, with no repetition of the examination-in-chief.

6. submission of oral evidence according to subject matter rather than according to the order of presentation of parties. For example, all evidence on hydrogeology, from all parties, would be heard together so that parties and the Board would not have to refresh their memories with respect to the proponent's evidence on hydrogeology after the proponent had completed its case.

The Board also considers that a well-informed public leads to a shorter hearing. For this reason the Board attempts to assist people who may not have participated in the environmental assessment or the hearing process before by providing access to its administrative staff and to publications such as the Board's Citizens Guide, as well as applying more informal procedures to unrepresented parties during the hearing itself.

There is another facet to ensuring accessibility and fairness and expediting the hearing and that is by providing financial assistance to intervenors.

The EAB has been convinced for some time that the provision of financial assistance for participants in its hearings provides major benefits to the process. Responsible representation of the public interest helps to ensure that all of the issues are identified and that there is a balance of evidence for the Board to examine in reaching its decisions. Funding well in advance of the hearing helps affected parties to plan for a more meaningful participation. It makes the process more efficient and, in our experience, shortens the hearing time.

The Government of Ontario has taken major initiatives to provide intervenor funding.

Since 1984 advance funding has been provided by Orders in Council for several hearings. Each Cabinet Order has authorized the Board to distribute a specific amount of money among potential participants who qualify under the eligibility criteria included in the Order. That amount was usually $30,000., but $300,000. was provided for the Timber Management hearings currently underway in Thunder Bay. This was recently supplemented by $450,000. for the coming year. Consideration of who gets what proportion of that funding is currently underway.

For the upcoming Ontario Waste Management Corporation hearings, the Order in Council differed from the others. In the OWMC case, the Board was authorized to make recommendations to the government as to the total amount of funds to be provided, along with recommendations for amendments to the eligibility criteria to be applied, and to distribute the funds once approval had been given by government.

In December, 1988, the Funding Panel recommended a funding program to the Minister of the Environment which would comprise the distribution of about $3.8 million dollars over a period of 2 years to 3 intervenors: the Regional Municipality of Niagara, the Township of West Lincoln, and the Ontario Toxic Waste Research Coalition. The Panel recommended that the funding criteria be amended to provide that legal fees be eligible for reimbursement at the rates used by government when it engages private counsel. The original order in Council had required that Legal Aid Plan rates apply.

The Ontario Cabinet approved the proposed program with the exception of the recommendation respecting legal fee rates. In the result, the funding program will provide $3.2 million dollars to the 3 funded parties to assist in their preparation for and participation in the OWMC hearing.

It should be noted that OWMC had previously provided funding to potential participants to a total of $2.4 million dollars since 1985. The bulk of the OWMC funds were provided to the 2 municipalities where the site is proposed to be located.

The most recent initiative by the provincial government was the introduction of the Intervenor Funding Project Act (Bill 174) which received royal assent on December 15, 1988 and was proclaimed on April 1, 1989. Part 1 of this Act sets out a pilot project for a trial period of 3 years. It gives potential public interest participants the right to apply for financial assistance in connection with hearings before the Environmental Assessment Board, Joint Boards and the Ontario Energy Board. Funding may be awarded by a panel comprised of a member of the Board before which the hearing is to be held or a panel of 2 members in the case of a Joint Board.

The Funding Panel has the authority to award funds to be paid by the funding proponent named by the Panel in accordance with the terms set out in the Act. During the 3 year period, the Act provides that the Hearing Panel may award supplementary monies to the funded parties during the hearing should it be convinced that more assistance is needed during the hearing.

Part 2 of the Act gives the Environmental Assessment Board the power to award costs. These cost awards may be given on the basis of criteria which may differ from the criteria used by the courts (that is, costs need not be paid by the losing party to the winning party). The new Act (Bill 174) does not however spell out the criteria which are to be used in making cost awards under the Act.

I have talked about what the Board has been doing and the direction it is taking with respect to upcoming hearings. These actions are necessitated by a public and government perception that the EA process is too lengthy and expensive, and of course the hearings are the most public part of that process.

What we expect from consultants, government officials, citizens and lawyers is a recognition that hearings must take up less time while dealing fairly with all of the major issues surrounding the proposal under consideration. Parties must be prepared to state their major issues and proceed with the hearing on those grounds, after a good faith effort at resolving issues and eliciting areas of agreement. "Discovery" of the contents of each party's evidence will not take place at the hearing, but prior to the hearing.

The "leaving no stone unturned" approach to presentation of oral evidence and conduct of cross-examination will no longer be tolerated. Cost awards may be used to reinforce that message, although the Board will take into account the particular circumstances, and will guard against awards which might prejudice unrepresented or inexperienced parties. The Board will continue to keep the goal of efficiency in mind, and will expect parties participating in its hearings to guide themselves in accordance with that goal.

SESSION II – WASTE MANAGEMENT

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Technical Services, Sanivan Group
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C. Simons, Environmental Manager
Alberta Special Waste Management
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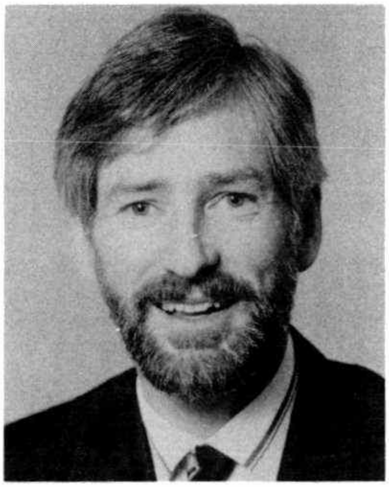

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HAZARDOUS WASTE MANAGEMENT STRATEGY FOR THE 1990's

Steven E. Radcliffe,
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September 1985 amendments to Ontario Regulation 309 under the Environmental Protection Act introduced a cradle-to-grave program for the management of hazardous and liquid industrial waste (hereinafter hazardous waste). Generators of hazardous waste , if found subject to the regulation, must register with the Ministry of the Environment's (MOE) Waste Management Branch. A six-part manifest form must accompany shipments of hazardous waste , by certified haulers, on its way to certified hazardous waste management facilities. The manifest form is used to track the fate of hazardous waste from where it is generated (cradle) to where it is treated or disposed (grave). The next step in the evolution of hazardous waste management policy development was a stakeholders' forum held in Bolton in December 1986. This was followed by a more focussed discussion at a similar forum held at the Nottawasaga Inn in September 1987. The MOE has very recently developed a draft strategy document as a follow-up to these previous events. The strategy addresses design & operating standards and financial assurance for hazardous waste management facilities; the concept of Best Management Practice for hazardous waste generators; the transboundary movement of hazardous waste and proposed amendments to Regulation 309. These issues were discussed at a third and final stakeholders' forum held at the end of March 1989 also at the Nottawasaga Inn.

The MOE recognizes that there is room for improvement and feels that the draft strategy, described as follows, will address this matter. A comparison was made between performance standards and design standards for hazardous waste management facilities. Performance standards specify the end and leave the means subject to flexibility and innovation. Design standards, on the other hand, specify the means to an end. The MOE's recommendation is to adopt performance standards augmented, where necessary, by technical standards. Operating requirements for hazardous waste management facilities are currently addressed on a case-by-case basis in the form of conditions on a Certificate of Approval (C of A). The MOE intends to clarify and standardize these requirements into formal standards. These will address areas such as sampling & verification of incoming wastes, site security and inspections and closure/post-closure plans. Financial assurance for hazardous waste management facilities has been applied inconsistently in the past. It too is currently addressed on a case-by-case basis in the form of conditions on a C of A. The MOE intends to develop formal standards to augment current guidelines, in the areas of liability insurance, operating securities and closure/post-closure securities. It is recognized that generators of hazardous waste should take a more active interest in the proper management of these wastes. The intent is to push the management of hazardous waste up the hierarchy, from disposal at the bottom to the 4Rs (reduce, reuse, recycle and recover) at the top. The MOE's draft strategy puts forth various options, ranging from a technical assistance program to a waste end tax, for the implementation of a Best Management Practice (BMP) plan. BMP is described as the utilization of the most desirable method or combination of methods from the waste management hierarchy, consistent with process, economic and other practical limitations. The draft strategy also included an examination of transboundary movements of hazardous waste. The factors contributing to such movements were examined and a recommendation was put forth that despite an imbalance in import/export hazardous waste quantities, Ontario's borders shall remain open. Lastly, proposed amendments to Regulation 309 were introduced to address such issues as wastes from small quantity generators, product stewardship, waste samples, corrosive solid waste and the mixing of hazardous wastes with other wastes and other materials. The most significant change proposes a paperwork control mechanism, called a roster, to track small quantity hazardous wastes and those wastes currently exempted by other means (eg. service station wastes and wastes from medical offices). A roster differs from a manifest in that generator registration would not be required and data would be reported on a summary basis by the carrier and the receiver.

The next step in the development of MOE's hazardous waste management strategy for the 1990's is the refinement of the draft document based on feedback from the March 1989 forum. This strategy must then be integrated with other MOE waste management initiatives and following public review, legislative/policy changes may be in order to implement the strategy.

HAZARDOUS WASTE MANAGEMENT

STRATEGY FOR THE 1990s

BACKGROUND

- REG 309 CRADLE-TO-GRAVE IN PLACE
- READY FOR THE NEXT STEP
- ROOM FOR IMPROVEMENT
- PUBLIC, MEDIA AND STAKEHOLDERS' CONCERNS

BACKGROUND

- PROPOSED REGULATORY/POLICY STRATEGIES
- STAKEHOLDERS' FORUM MARCH 1989
- STRATEGY DOCUMENT
    - OVERVIEW DOCUMENT
    - SIX APPENDICES

HAZARDOUS WASTE MANAGEMENT STRATEGY FOR THE 1990s

- OVERVIEW DOCUMENT
- APPENDICES
    - TRANSBOUNDARY SUBJECT WASTE TRANSACTIONS
    - DESIGN STANDARDS
    - OPERATING STANDARDS
    - BEST MANAGEMENT PRACTICE
    - FINANCIAL ASSURANCE
    - PROPOSED AMENDMENTS TO REGULATION 309

STAKEHOLDERS' FORUM

- MARCH 27-29, 1989 NOTTAWASAGA INN
- WASTE GENERATING INDUSTRY
- WASTE MANAGEMENT INDUSTRY
- FEDERAL AND MUNICIPAL GOVERNMENTS
- NON-GOVERNMENTAL ORGANIZATIONS
- DISCUSSED STRATEGY ISSUES
- CONCURRENT WORKSHOPS & PLENARY

TRANSBOUNDARY WASTE TRANSACTIONS

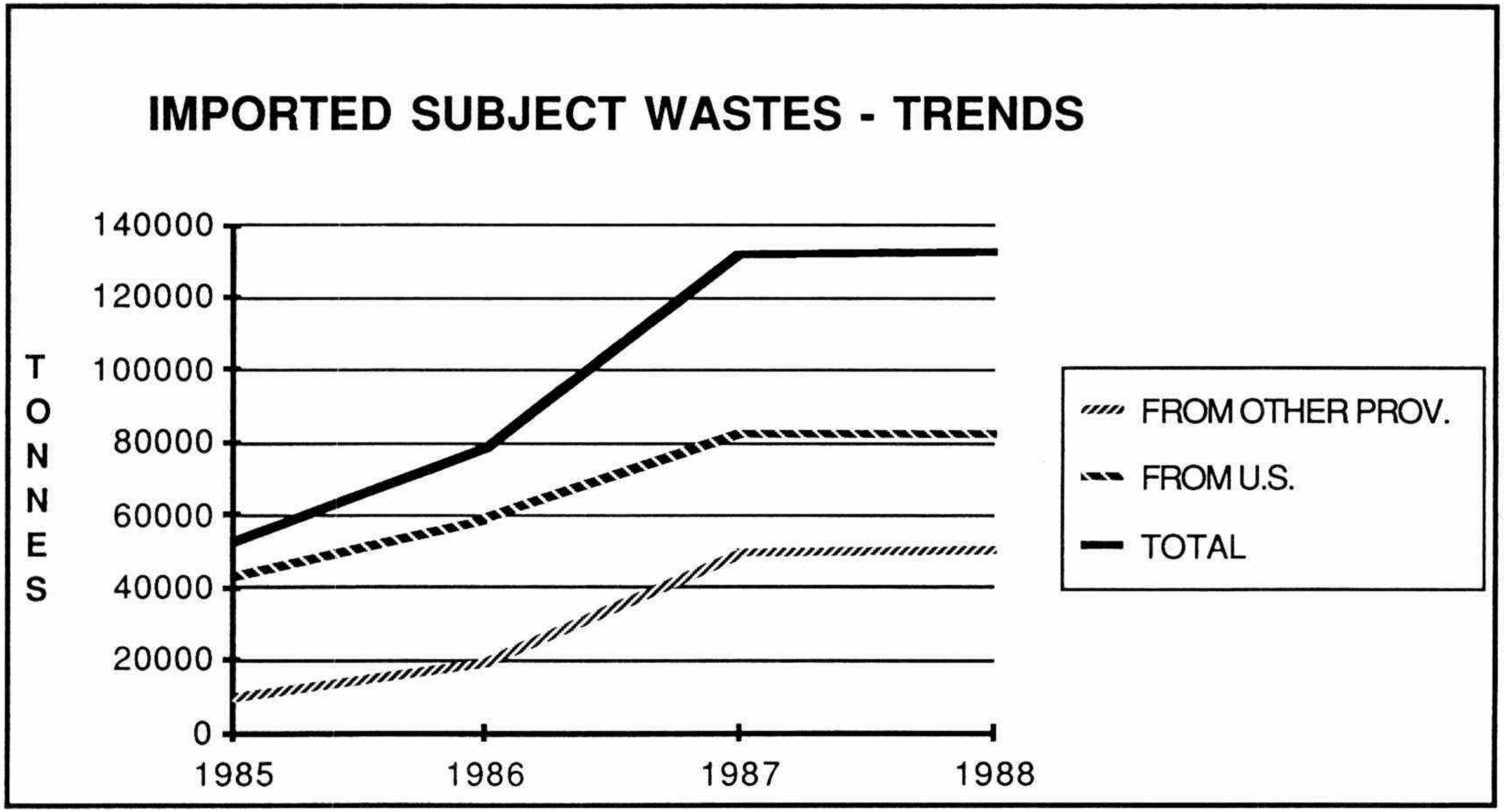
- ONTARIO NET IMPORTER SINCE MID-1985

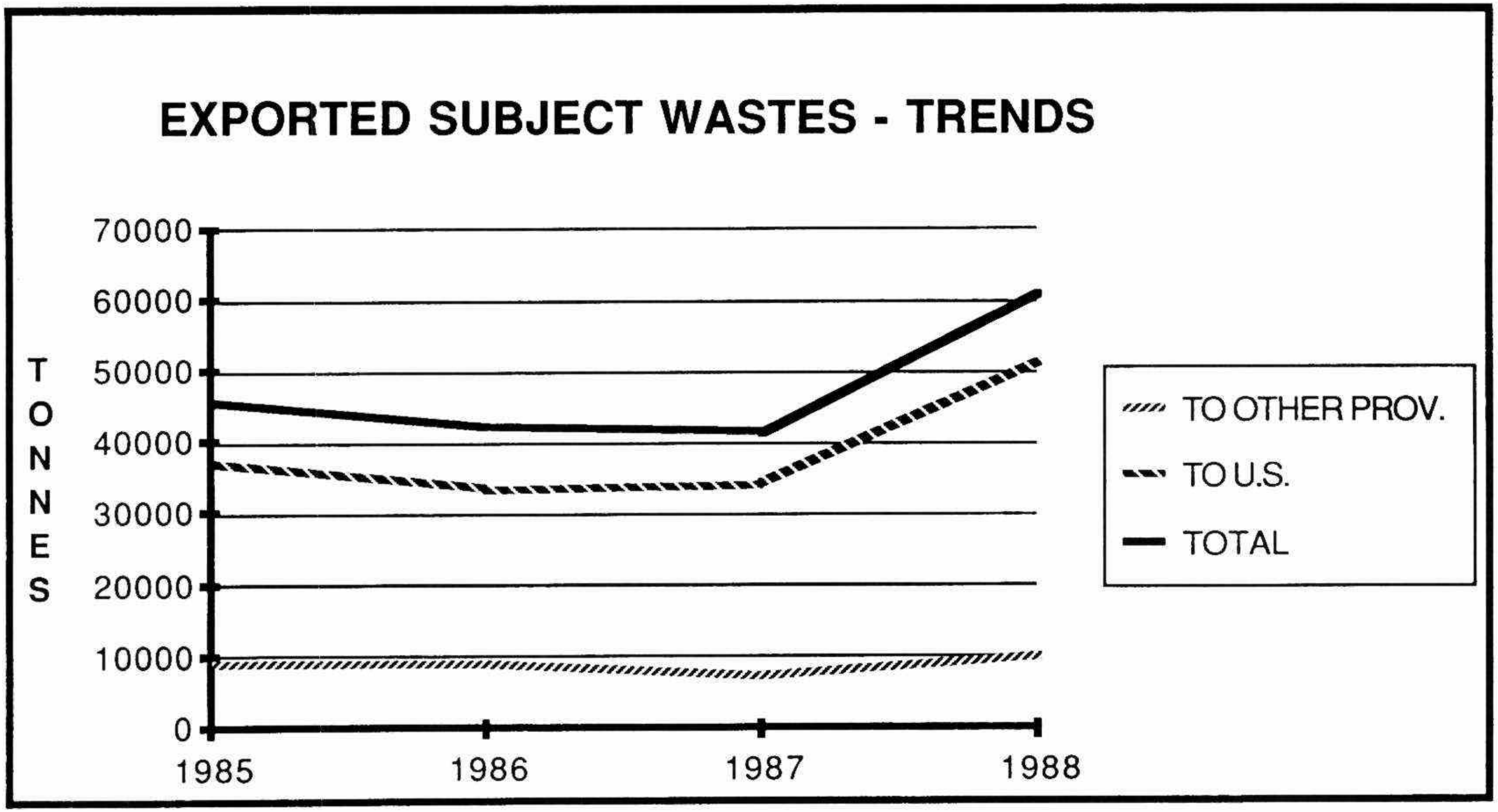
- 1988 STATISTICS

IMPORT	EXPORT
133,032 TONNES	61,085 TONNES

- FACTORS INFLUENCING IMPORT/EXPORT

- CONSENSUS THAT BORDERS REMAIN OPEN


IMPORTED SUBJECT WASTES - TRENDS
TONNES
140000
120000
100000
80000
60000
40000
20000
0
1985
1986
1987
1988
FROM OTHER PROV.
FROM U.S.
TOTAL



EXPORTED SUBJECT WASTES - TRENDS

OPERATING STANDARDS

- HAZARDOUS AND LIQUID INDUSTRIAL WASTE EPA PART V FACILITIES

- PROPOSE TO CLARIFY AND STANDARDIZE REQUIREMENTS INTO FORMAL STANDARDS

- ADDRESSES
    - SAMPLING & VERIFICATION
    - SECURITY
    - INSPECTIONS
    - TRAINING
    - EMERGENCY & ACCIDENTS
    - CLOSURE & POST-CLOSURE

DESIGN STANDARDS

- HAZARDOUS AND LIQUID INDUSTRIAL WASTE EPA PART V FACILITIES

- TECHNICAL STANDARDS

- PERFORMANCE STANDARDS

- RECOMMENDATION

  - PERFORMANCE STANDARDS AUGMENTED BY DESIGN STANDARDS

BEST MANAGEMENT PRACTICE

- FOR GENERATORS OF HAZARDOUS AND LIQUID INDUSTRIAL WASTE

- TOXICITY REDUCTION

- IMPLEMENTATION OPTIONS

  - BMP PLANS
  - ANNUAL REPORT
  - MANIFEST DECLARATION
  - TECHNICAL ASSISTANCE PROGRAM
  - SECTORAL GUIDELINES
  - WASTE END TAX

WASTE MANAGEMENT HIERARCHY

- **REDUCE**
- **REUSE**
- **RECYCLE**
- **RECOVER**
- **TREATMENT**
- **INCINERATION**
- **STORAGE**
- **DISPOSAL**

FINANCIAL ASSURANCE

- EPA PART X-A AND GUIDELINE
- SITE-BY-SITE INCONSISTENCIES
- INSURANCE, OPERATING SECURITIES AND CLOSURE/POST-CLOSURE SECURITIES
- PROPOSED STRATEGY
    - MANDATORY VS DISCRETIONARY
    - MINIMUM LIABILITY REQUIREMENTS
    - LONGER TERM SECURITY UNIQUE TO FACILITY TYPE

PROPOSED AMENDMENTS TO REGULATION 309

- ROSTER WASTE
  - CONTROL OF ALL HAZARDOUS AND LIQUID INDUSTRIAL WASTE
  - NO GENERATOR REGISTRATION
  - CARRIER AND RECEIVER FORMS REPLACE MANIFEST

- PRODUCT STEWARDSHIP

FUTURE ACTION

- REVISE STRATEGY DOCUMENTS
- INTEGRATE WITH WASTE STRATEGIES
- PUBLIC REVIEW
- LEGISLATIVE/POLICY CHANGES

PROPOSED AMENDMENTS TO REGULATION 309

- WASTE SAMPLES

- CORROSIVE SOLID WASTE

- MIXING RULE

CLEAN-UP FOLLOWING THE PCB FIRE AT ST.BASILE-LE-GRAND

by Jean Paquin, Sanivan Group

August 23, 1988, 8 : 45 PM, a fire is raging in a PCB warehouse in Quebec's St.Basile-le-Grand. Three thousand people are evacuated from the neighboring municipalities.

It is one of the worst environmental accidents to happen in Canada. Once the plume of airborne soot has dispersed, the ruins, a mass of damaged drums and capacitors, ash, free liquid and a collapsed structure, continue to represent a risk for people and the environment.

Within hours, environmental emergency measures are taken on site by the Sanivan Group under the authority of the Quebec Ministry of Environment. The water used to put out the fire is confined to the site and collected. Personal protective equipment is brought in; spill response equipment is mobilized.

In the days that follow, decontamination facilities are set up, the scattered debris around the warehouse are collected and secured, contaminated fluid leaving the remains of the building is spotted and stopped, contaminated soil is collected and drummed. Water treatment is initiated, and a wide sampling and analytical program starts.

Control of access is organized to insure the protection of people coming to the site and to prevent the spreading of contaminants. The company medical program for PCB's is extended to include all people having to work on site.

Seventeen days after the evacuation, the residential areas are declared safe and the population returns to their homes. Meanwhile the warehouse site is fenced off and placed off-limits for the general public.

The Quebec government calls for tenders to clean up the site, and two firms forming a joint venture are retained : Sanexen, a member company of Sanivan Group, and MacLarentech, a subsidiary of Lavalin. The contract, awarded on October 6th, is a lump sum contract and calls for the completion of all site clean-up work before Christmas.

To guarantee health and safety at the site, and to accomodate the work crews, a complete infrastructure is set up. The site is divided between contaminated and non-contaminated areas and a ten trailer village is assembled. The village houses the change rooms and locker room, showers, sanitary facilities, a store and a decontamination area for personal protective equipment, offices and a cafeteria. It also serves the purpose of controlling access to and from the contaminated area.

Every phase of the operations is supervised by the Ministry of Environment of Quebec and by the Commission de la santé et sécurité au travail. The workers, more than one hundred and thirty, go through an entry medical examination and undergo complementary training before assuming their duties.

Shelters are erected alongside the warehouse to handle all the contents of the warehouse. There are three main types of articles to be cleared : drums, capacitors and transformers. During a period of six weeks, 3894 drums, 5665 capacitors and 214 transformers are identified, washed, inspected, sampled, logged, tagged and secured for safe storage and transportation off site.

The contents of each drum are identified through their physical characteristics, appearance, color, viscosity and density; tests are run to measure any radioactivity and explosivity. Approximately ten per cent of the samples are sent to a laboratory for a PCB analysis. At the end of the handling chain the drums are placed into new overpack drums.

Capacitors are similarily moved out of the warehouse and are then stocked with absorbent materials into specially constructed steel vaults. Transformers are drained when they contain liquids and also go through the sequence of identification and washing; they are then filled with absorbent material and are braced into 20' transportation containers.

Leftover fluid from transformers and from damaged drums is transferred into new sixteen gauge drums; empty drums are then crushed and placed into steel vaults.

All drums and transformers are placed into containers equipped with retention pans. Packaging and bracing of the items are supervised by several provincial and federal government agencies. In all, one hundred and twenty five containers along with sixty two vaults are required to store the contents of the warehouse and the associated waste.

In conjunction with these operations, a decontamination facility is set up and receives the miscellaneous equipment present on site during the fire. An emulsifying solution is applied to the surfaces and cleaning then proceeds with high pressure water jets. The washwater is directed to the wastewater treatment facility located on-site.

The structure and sheet metal of the warehouse are dismantled and are also sent to the decontamination area. All surfaces are cleaned to concentrations less than one milligram of PCB per square meter to meet standards for cutaneous contact and the items are then released from the site for recycling.

All contaminated water from the site, including firewater, subsequent runoff water and washwater is collected and treated on site. A modular water treatment facility is used to process two million eight hundred liters of wastewater during the operations. The treatment criteria are stringent : less than one part per billion of PCB's and less than one part per trillion of dioxins (PCDD) and furans (PCDF) are tolerated. Inlet concentrations range between 20 ppb for runoff water to 380 000 ppb for washwater. The average PCB:PCDF ratio is 3 000 to 1. Most of the PCB present is the more water soluble PCB 1242.

Incoming water is segregated, pretreated according to its origin, and run through two parallel ultrasorption systems. The effluent is directed into tankage, sampled, analysed and approved prior to discharge. The dewatered treatment sludge is placed in drums in a dry form. This operation allowed the recovery of 1,3 metric ton of PCB.

Finally the concrete floor of the warehouse is washed, sampled, sawed in blocks and packaged for disposal. Soil contamination is characterized and mapped.

Demobilization is completed on December 23, 1988; the work proceeded night and day for a period of eleven weeks.

In summary, the techniques and procedures established previously, and used to respond to the incident, allowed to meet the project objectives. The health and safety protocole, the identification, decontamination and water treatment procedures, however all had to be adapted to fit the situation; optimization was required in several cases and implementation had to be prompt to accomodate the tight schedule.

One of the elements contributing to the achievement of the clean-up objectives was the establishment of a team comprising of operational, technical and administrative blocks dedicated to on-site organisation and problem solving. The very close coordination of the on-site Ministry of Environment group and the Sanexen-MacLarentech team was also invaluable to the success of the project.

ALBERTA'S SPECIAL WASTE MANAGEMENT PROGRAM

by

C.S. Simons, Environmental Manager, Alberta
Special Waste Management Corporation, Edmonton,
Alberta

Background

The Alberta Special Waste Management System is the result of close to ten years of effort by Alberta's government, industry and public at large. In the late 70's and early 80's the Alberta government set as its priority the development of an appropriate province wide program for the management of hazardous wastes. The cornerstone of the resultant special waste management system is the Treatment Centre, sited and built near Swan Hills. The system also includes a province wide collection, transfer and transportation network.

Following site selection in early 1984, the Alberta government created the Alberta Special Waste Management Corporation. This corporation is an Alberta Crown Agency, mandated to "establish and ensure the safe operations of facilities to deal adequately with Alberta's hazardous wastes".

In developing the Special Waste Management Program, objectives included that the resultant system would have to meet the following criteria:

- The treatment centre be comprehensive and integrated so that all Alberta wastes could be completely treated at one location.

- The site be accessible to all Albertans. Geographically this would be addressed through the development of a comprehensive collection and transportation system. Financially a postage stamp rate concept would be incorporated for transportation so that no user would be unfairly burdened due to location.

- "State-of-the-art" technology be incorporated in the plant design.

- The site be both technically sound as well as socially acceptable.

The Alberta Special Waste Management Corporation (ASWMC) entered into a joint venture agreement with Bow Valley Resource Services Ltd. to develop and own the facility. Through this joint venture, Chem-Security (Alberta) Ltd. (CSAL) was contracted to build and operate the facility. As well, CSAL supervises the transfer and collection stations and manages the transportation system.

Facility Design Criteria

Design of the treatment centre required knowledge of both the volumes and types of waste which would require treatment. Waste inventories suggested that Alberta produced some 100,000 to 200,000 tonnes of hazardous waste annually. Based on European experience and advice, it was expected that some 20% of this material might require off-site treatment. Therefore, a conservative initial design capacity was set at 20,000 tonnes annually, in two phases. The first phase considers 10,000 tonnes of organic materials and 5,000 tonnes of inorganic materials. In addition, the plant was designed to treat any hazardous waste produced in Alberta excepting explosives and radioactive materials.

Four main guidelines were adopted in facility design; including:

- Build Small - plant capacity can always be expanded if needed.

- Build Flexible - by minimizing the interdependence of treatment processes the facility can more easily accommodate process modifications or additions.

- Use Modular Components - standardizing facility components as much as possible ensures easy access to replacement or additional parts, and minimizes design and engineering costs.

- Review New Options - because of the dynamics of treatment technologies in the waste management field, new technologies would be reviewed on an ongoing basis to ensure any further developments of the treatment centre take advantage of the latest proven technologies.

The Treatment Centre

The treatment centre, located some 250 kilometers northwest of Edmonton near the town of Swan Hills, was officially opened in September 1987.

The main treatment processes comprising the facility include:

- high temperature incineration
- physical/chemical treatment, and
- stabilization.

Following treatment, the non-hazardous solid residues are placed in a covered secure landfill cell and the treated waste waters are injected down a deepwell.

To enter the system, waste generators must disclose the chemical composition of their waste and submit a sample of the same to the treatment centre. The samples are analyzed to confirm their composition and to decide upon the appropriate handling, treatment and disposal procedures. At this point a contract is completed and the waste is scheduled for treatment. Once the waste enters the Alberta system, ownership and liability are transferred to the Special Waste Management System.

The transportation system which links the collection network with the treatment centre is coordinated with the treatment centre's scheduled operating plans. Drummed wastes are transported within steel, marine style containers. Drained PCB contaminated transformers are transported within drip trays on covered flat beds. Liquid tankers are used to move bulk liquids and diaphered dump trucks are used to transport low-level contaminated soils.

Organic wastes such as solvents, pesticides, oils and PCBs are destroyed using high temperature incineration. The incineration facility consists of two rocking kilns, each with a dedicated secondary combustion chamber, and a common flue gas purification system. The rocking kilns can accept liquids, sludges and solids which may be fed simultaneously. The kiln rocks through an angle of about 90° to provide the solids mixing. Periodically the kiln is rotated through an angle of 180° to discharge slag and ash.

Gases from the kiln are routed through the secondary combustion chamber which operates at a minimum of 1200°, burning fuel gases only. The exhaust gases from each secondary combustion chamber are combined and routed through the flue gas purification system. This system first quenches the gases from 1200° to 80°C, then removes particulates and acid gases prior to releasing the gases to atmosphere through a 20 meter stack.

Inorganic wastes such as acids, alkalies and heavy metal bearing liquids are treated by physical/chemical processes such as neutralization, oxidation, reduction and precipitation. This plant, designed to treat 4000 tonnes per year, consists of two dedicated reactor systems with their associated pumps, agitators and controls. One of the reactor systems is polypropylene lined allowing it to handle acidic materials. The other is lined with teflon and is used for the treatment of alkalines, cyanides and sulphides. All treatments are first formulated in the laboratory prior to full scale treatment. Resulting solids and sludges are separated from liquids using a filter press. The filter cake is then further processed at the stabilization plant and the treated wastewater is pumped down the deepwell.

Treatment residues and low level contaminated solids are treated in the stabilization unit. Chemicals such as lime or fly ash are mixed with the waste materials to immobilize contaminants. Materials requiring stabilization are fed via a front end loader and skiphoist to the pug mill batch type mixer. Stabilized materials are then discharged into a truck for placement in the landfill cell. Treatments are first formulated in the laboratory prior to full scale treatment.

The secure landfill is comprised of a series of cells excavated in a 15 meter thick layer of dense clay. Only dry, treated, solid residues are ultimately disposed of in the cells. Further, the cell is covered with a portable, rigid structure during its operational life to ensure that no precipitation enters the cell. When a cell has been filled, it is capped with a plastic liner and clay. The surface is then revegetated.

The disposal well is drilled to a depth of 2045 meters and receives treated wastewaters from the physical/chemical treatment facility as well as incinerator scrubber blowdown and excess surface water runoff.

Operations

The treatment centre's first year of operations focussed on attaining a full operating licence. The first 3 months following the plant's official opening was spent on mechanically commissioning and verifying unit operations.

On February 1, 1988 a 5 month long performance evaluation program was initiated to determine the incinerators destruction and removal capabilities as well as to determine emission levels for the stack gases. The program was designed to evaluate the system performance against regulatory criteria set out by Alberta Environment and design criteria guaranteed by the incinerator manufacturer.

Alberta Environment specified maximum allowable stack gas concentrations as follows:

Total Particulate	70 mg/m^3
HCl	150 mg/m^3
SO_2	650 mg/m^3
HF	7 mg/m^3
CO	140 mg/m^3
PCBs	1 mg/kg PCB in feed
Sum of dioxins and furans	45 nanogram/m^3

These concentrations are based on 1 hour average emission rates referenced at 25°C, 101.325 kPa and 50% excess air on a dry basis.

The first two trial burns demonstrated the general capabilities of the system using what turned out to be the most difficult to destroy compound or principal organic hazardous constituent. Subsequent tests using four principal organic hazardous constituents demonstrated that system performance meets and often exceeds, by a substantial safety margin, the design specifications and regulatory requirements. The tests have also demonstrated the preferred operating conditions which lead to the best overall system performance.

Some of the more significant test results are summarized below:

Test Condition	Design Capacity 1200°C	126% Design Capacity 1125°C
DRE-trichlorobenzene	99.99999%	99.9999%
-PCB	99.99999%	99.99999%
Emissions (mg/m^3)		
Particulates	11.1	59.9
CO	10	10
HCl	4.8	0.93
total dioxins (ng/m^3)	BDL*	2.5
total furans (ng/m^3)	BDL	2.0

* BDL = below detectable limit

Following a number of months of data interpretation and a detailed review by Alberta Environment, a full operating licence was issued on November 1, 1988. The Alberta Special Waste Treatment Centre is thus Canada's first facility licenced to destroy PCBs.

In only seven months of full plant operations the demand for solid waste incineration has increased significantly. This, coupled with higher than expected BTU value waste streams has lead to an early decision to expand our incineration capabilities. Work is commencing on the procurement and installation of a small rotary kiln to deal with this shift in waste streams.

Collection and Transfer

Major producers of hazardous waste can now readily access the treatment centre.

Our studies show that 80 to 85% of all wastes destined for the treatment centre will be shipped directly from the point of generation. While this is effective for large volume generators, producing full truck loads of waste, it does not adequately address the collection of wastes from small quantity waste generators.

Current efforts in furthering development of a comprehensive waste management system are being directed towards the establishment of a network of regional collection and transfer stations.

Two interim transfer stations currently exist, one in the Calgary area, the other near Edmonton. These two regions, being the provinces largest industrial centres, are expected to handle about half of all those materials which will be routed through transfer stations.

Transfer stations allow small quantity generators ready access to the system by allowing them to deliver materials to the transfer station directly or through using the services of a waste broker or agent. These materials are collected and temporarily stored at the transfer station until a sufficient volume of compatible wastes has been accummulated to make up a truckload for shipment to the treatment centre.

Seminars and workshops have been held throughout the province to inform waste generators and the general public of Alberta's Special Waste Management System. Initially, to encourage the participation of the private sector, we specifically addressed small businesses to highlight the new regulations as well as highlighting the various potential business opportunities.

More recently, study sessions have been initiated in interested communities (with town councils support) with a group of non-elected citizens. The corporation's objectives in conducting these sessions is to increase the general publics understanding of hazardous wastes and to gain their support in the development of a comprehensive management network. These citizens groups are ultimately responsible for reporting back to their town council on their findings and recommendations regarding hazardous waste management on a local scale.

In conjunction with these study sessions, public involvement and awareness has been greatly increased through the development and implementation of a province wide program for the collection of household hazardous waste as well as for old and expired medications.

A 30-second television commercial and a 30-minute documentary have both been aired extensively throughout the province. Efforts are now being made to have hazardous waste management considered in the new junior-highschool environmental studies curriculum.

Through the continued use of public meetings, presentations and programs such as the household toxic round-ups, the ASWMC hopes that all Albertans will soon recognize both the need for proper waste management, and their responsibility for ensuring it happens.

ENVIRONMENTAL DECOMMISSIONING OF A MANUFACTURING PLANT

by

R. C. Dickin, Senior Hydrogeologist, Gartner
Lee Limited, Markham, Ontario

This paper describes the environmental decommissioning of an old manufacturing plant and illustrates the multi-facetted, multi-discipline nature of this type of project.

The purpose of the decommissioning was to identify and remediate any significant environmental contamination on the property caused by manufacturing operations, which would be a concern if the site was redeveloped for light commercial and residential uses.

The owner of the property was moving the manufacturing operation to a more modern building on another property which would allow the manufacturing process to be more efficient. The owner wanted to sell the property to a responsible developer and wanted to work with the him to ensure that the redevelopment did not create any environmental liabilities for either party.

The site was originally developed in the 1830s for saw mills, flour mills and warehouses. More recent industrial use of the property included an iron foundry, a brass and bronze foundry, metal plating, spray painting and machining.

A number of environmental regulations and guidelines were considered during this decommissioning. Four of the more important ones are listed below:

a) Guidelines for the Decommissioning and Cleanup of Sites in Ontario, February 1989.

b) Ontario Regulation 309 (Environmental Protection Act), June 1985.

c) Ontario Regulation 11/82 (Environmental Protection Act), January 1982.

d) Ontario Regulation 654/85 (Occupational Health and Safety Act), 1985

The Decommissioning Guidelines provide limits for total concentrations of metals and other contaminants in soils for either commercial/industrial or residential/parkland redevelopment.

Regulation 309 provides criteria for leachable concentrations of various contaminants and classifies materials as hazardous wastes, registerable wastes or non-registerable material. Hazardous wastes and registerable wastes must be registered with the MOE, manifested for transport and must be disposed of at an appropriately approved waste disposal facility.

Regulation 11/82 classifies material with over 50 ppm PCB as "PCB wastes". This regulation and several handbooks available from the MOE and Environment Canada provide information on the proper handling and storage of PCB wastes.

Ontario Regulation 654/85 of the Occupational Health and Safety Act requires that friable asbestos be removed from buildings prior to demolition and provides direction on the correct removal methods.

The overall structure of this decommissioning project involved the following steps:

a) environmental investigations to determine the nature and extent of any contaminant problems;

b) review of the environmental report and consultations with the property owner, the property buyer, the MOE and various advisers such as lawyers, real estate agents and architects;

c) development of a decommissioning plan;

d) review of the decommissioning plan by the MOE and other interested parties;

e) implementation of the decommissioning plan and remedial measures;

f) final report preparation and MOE review; and

g) MOE approval of the redevelopment.

The tasks which were completed as part of the environmental investigations to identify and assess contaminant problems on the property are listed below:

  a) initial investigations

  b) surface soil sampling

  c) geophysical survey

  d) drilling and subsurface soil sampling

  e) ground water testing

  f) building material testing

  g) asbestos inventory

h) PCB inventory

i) miscellaneous chemicals inventory

The initial investigations involved interviews of long-term employees and review of the plant processes and history. Review of available site plans, reports and maps as well as stereoscopic interpretation of historical aerial photographs was also carried out.

The purpose of these initial investigations was to identify areas of concern which warranted more detailed sampling and analysis.

The next task was to collect composite samples of the surface soils in the identified areas of concern. The approach used on this project was to sample areas of stained or discolored soil in areas where chemicals or wastes were routinely handled. An alternative approach would be to collect composite soil samples on a grid basis across the entire site. The surface soil samples were tested for the parameters listed in the Decommissioning Guidelines. Many of the samples exceeded one or more of the soil clean-up criteria including some of the background soil samples collected in urban areas far removed from the site. The collection of background samples is, of course, an integral part of any soil sampling survey.

A geophysical survey was carried out to map terrain conductivity anomalies on the property including any buried drums, metallic objects or conductive buried wastes.

A Geonics EM31 Terrain Conductivity Meter was used. This instrument consists of a transmitter coil, to produce an electromagnetic field and a receiver coil to measure the resultant electromagnetic field created in the ground. The electromagnetic field responds to variations in subsurface conductivity created by soil quality, soil texture, ground water quality and the presence of buried materials. The instrument has a fixed coil spacing that senses conductivity variations to a depth of about 5 m.

The survey was conducted along lines spaced about 2.5 m apart. Readings were taken at about every 0.8 m along these lines. the survey was not completed in areas where surficial noise (vehicles, buildings, rail lines, metal fences, power lines, above-ground drums, and other metallic objects) prevented the collection of quality data. Approximately 3000 data points were collected on the site in the space of two days using a computerized data logger.

The geophysical results were plotted as colour contours of terrain conductivity. Conductivity values representing background values typical of "clean" soils are shaded blue and green. Anomalously conductive terrain is represented by shades of yellow, red and purple. These elevated conductivity values may be caused by clay rich soils, buried waste and metallic materials, contaminated ground water and surficial noise. Selected high conductivity anomalies were targeted for further investigation in the drilling program.

A drilling and subsurface soil sampling program was carried out to further define the areas and depths of soil contamination. Chemical analysis of the soil samples indicated widespread exceedance of the Decommissioning Guidelines for copper, zinc and several other parameters related to phytotoxicology and agricultural considerations. A few samples also exceeded the Decommissioning Guidelines for cadmium, lead and mercury which are based on human health considerations.

Additional testing for Regulation 309 Leachate Quality Criteria was also carried out on selected soil samples. None of these samples exceeded the Regulation 309 Criteria by a factor of 100 or more, therefore, none of the soils were classified as hazardous wastes.

Ground water monitors were installed in a number of the boreholes. Ground water levels were measured and permeability testing was carried out to determine ground water flow directions and rates. Ground water samples were collected and submitted for chemical analysis. None of the Ontario Drinking Water Objectives related to health (MAC) were exceeded although several of the objectives related to aesthetic considerations (MDC) were exceeded. Since the plant and surrounding area are serviced with piped municipal water, this minor ground water quality degradation was not a major consideration in the decommissioning.

The building materials in the plant including floors, walls and roof were also tested for Regulation 309 Leachate Quality Criteria. Composite samples were collected from stained areas of known chemical usage. Regulation 309 testing indicated that the plating room floor and walls, and some stockpiled foundry sands were classified as hazardous wastes. The roof and foundry floor and walls did not exceed the Regulation 309 Leachate Quality Criteria by a factor of 10 or more. In addition, the concrete in the bottom of the plant degreasing pit was broken up and samples of the subfloor sands were tested for solvent concentrations. Only trace levels were found.

A subconsultant was retained to inspect the building for the presence of asbestos. About ten samples were collected and tested. Asbestos insulation was found on pipes in the boiler room and also as a fire retardant on beams in the foundry. Contract specifications were drawn up for asbestos removal prior to building demolition. A qualified contractor was retained and the asbestos was removed. A final report documenting the asbestos removal was prepared for the Ministry of Labour in accordance with Regulation 654/85 of the Occupational Health and Safety Act.

Various miscellaneous chemicals which had been left in the plant were inventoried, labeled, sampled and registered with the MOE prior to their removal from the site by a licenced waste disposal firm. A wide variety of chemicals including paints, solvents, plating solutions, oil and other chemicals had to be identified and dealt with in an appropriate manner.

There was also a concern about the possible presence of PCB's in electrical equipment. An inventory of the electrical equipment in the building was carried out by an electrical contractor. The six oil-filled transformers present on site were sampled and tested. One of them slightly exceeded the 50 ppm limit for classification as a "PCB waste". MOE Director's Approval was required for draining this transformer, transportation of "PCB wastes" and the establishment of an approved hazardous waste storage facility at the new manufacturing plant. Two small capacitors and fluorescent light ballasts which were also suspected of containing PCB's were also moved to the new plant for storage.

The environmental concerns identified during completion of the above tasks were documented in a report. Appropriate strategies for remediation were also presented. The report was submitted for review by the property owner, the redeveloper, the redevelopment architect, legal advisers, and the MOE staff.

The environmental investigation results were discussed and a number of remedial alternatives were considered and costed. A preferred remedial option was selected and a decommissioning plan report was prepared which outlined the details of the required decommissioning activities. The decommissioning plan report was then submitted for MOE review and comment prior to proceeding.

The main findings of the environmental investigations and the proposed remedial actions of the decommissioning plan are described below:

a) Almost all of the on-site soils exceeded one or other of the residential/parkland Soil Cleanup Guidelines. Only several smaller areas exceeded the Soil Cleanup Guidelines for cadmium, lead and mercury. These are the only three of the Cleanup Guidelines which are based on human health considerations. Guidelines for the other parameters are based on phytotoxicology or agricultural considerations.

   The decommissioning plan specified excavation and off-site disposal at an approved landfill for the soils which exceeded the lead, cadmium and mercury Cleanup Guidelines. Hard surfacing was proposed for the remaining areas in which the soils exceeded the guidelines for parameters like copper and zinc, which are not toxic to humans. It was decided to cover the entire property with a commercial shopping mall, roadways, parking lots or hard surfaced walkways. Residential components of the redevelopment plan were restricted to second storey or higher condominiums. All plantings were to be in raised gardens or pots.

b) The plating room floor and walls plus the foundry sands were found to be hazardous wastes under Regulation 309. They were excavated and disposed of at an approved hazardous waste facility. Two additional areas of stained subfloor soils which were identified and tested during the demolition and were also excavated and disposed of at an approved hazardous waste facility.

c) The asbestos and miscellaneous chemicals were removed from this site prior to demolition and were disposed of in an approved manner as described above. All electrical equipment containing PCBs were transferred to an approved storage facility at the new plant location.

One of the most difficult aspects of implementing the decommissioning plan was co-ordination of the demolition, trucking and waste disposal contractors. Excavation and loading of contaminated soils and building materials was supervised and follow-up sampling and inspections were carried out. Additional removal of contaminated material was required in a few locations based on the results of the follow-up sampling.

The site was inspected in conjunction with MOE staff following completion of the above tasks and demolition of all the buildings. Additional soil sampling and testing was carried out in a few locations at MOE's request. These laboratory test results did not indicate any contamination. A final report documenting the decommissioning was prepared for MOE review, in support of the application for a land use zoning change from industrial to commercial and high rise residential.

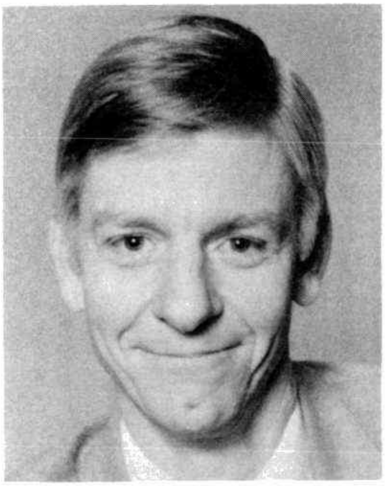
In summary, the decommissioning was a complex, multi-task project involving people from many different disciplines and professions. Maintaining communication between the various groups was probably the most important and most challenging aspect of the project.

SESSION III – AIR QUALITY MANAGEMENT

Moderator: Peter Brand
Past President, Air and Waste
Management Association, Toronto

Dr. L.M. Banbury, Manager
Environmental Control and
Occupational Health, Ontario Division
Inco Limited, Toronto, Ontario

Dr. C. Burnham, Environment Director
Ontario Hydro, Toronto



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THE SO_2 ABATEMENT PROJECT AT SUDBURY

by

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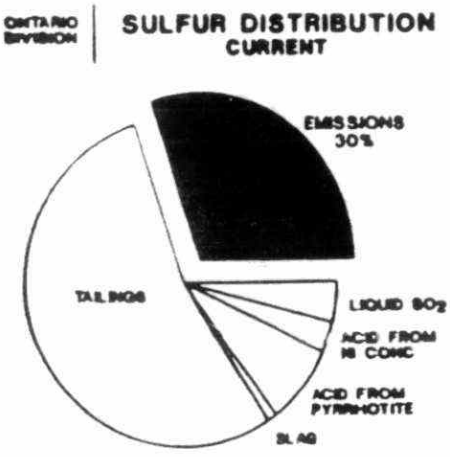
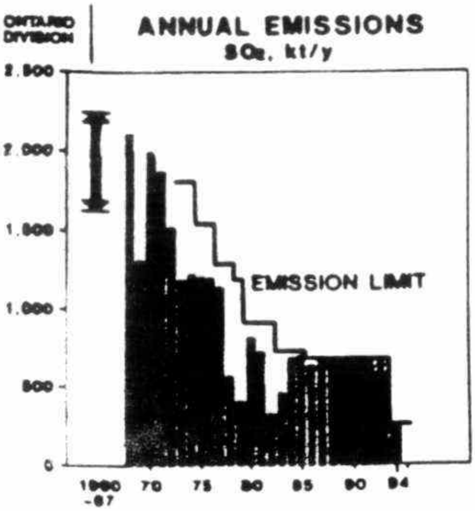
and Occupational Health, Inco Limited,
Copper Cliff, Ontario

Inco's SO_2 Abatement Program will lower sulphur dioxide emissions at Sudbury from the current levels of 685 thousand tonnes per year to 265 thousand tonnes per year by 1994 as required by Ontario's Countdown on Acid Rain regulations.

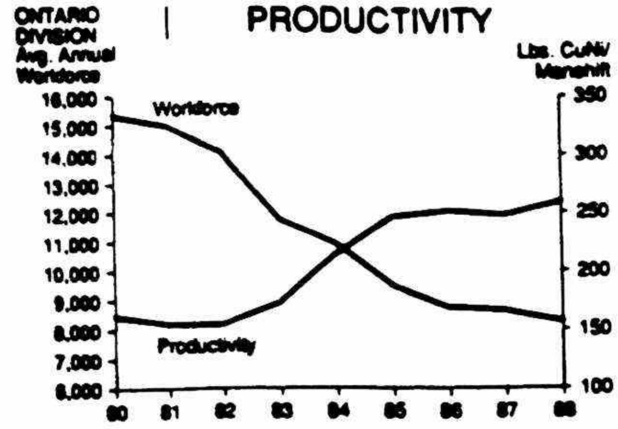
It is the high tonnage of sulphur mined that creates the magnitude of the SO_2 emission problem at Sudbury. At a production rate of 240 million pounds of nickel per year, Inco mines 12 million tonnes of ore. At 10% sulphur we mine 1.2 million tonnes per year of sulphur. If we did not fix any of this sulphur we would be emitting 2.4 million tonnes per year of sulphur dioxide - about as much as all other Canadian emissions. We are today however, already fixing 70% of the SO_2 in ore, in several ways: mostly as sulphur in pyrrhotite rejected to tailings in our milling operations; as acid from the roasting of pyrrhotite and some nickel concentrate at the Iron Ore Recovery Plant; and some as liquid SO_2 from the copper flash smelting furnace. By fixing 70% of the sulphur we meet the current allowable SO_2 emission levels of 685,000 tonnes per year. Total Sulphuric Acid Production is currently 450,000 tonnes per year and in fact, we are only continuing the IORP operation to maintain established acid markets.





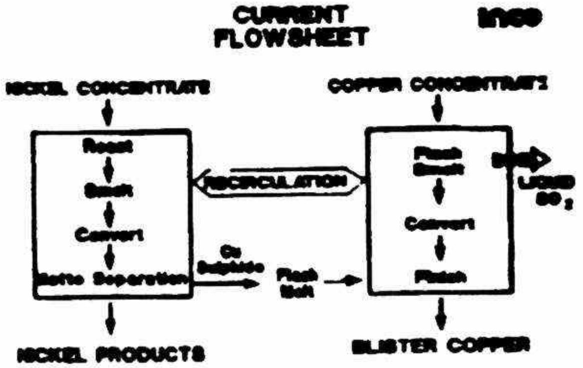
Historically we have reduced emissions from the two million tonne per year level to the current level of 685,000 tonnes per year by rejecting pyrrhotite from the smelter feed, and have already addressed 70% of the SO_2 containment problem at Sudbury.

While Inco's profits are large at current nickel prices, most people have forgotten that back in 1982 Inco was losing a million dollars a day. Inco did make a dramatic response to this economic stimulus. The Ontario Division increased productivity by 65% and lowered costs to become the lowest cost nickel producer.



In mining we converted to bulk mining methods using largely vertical retreat mining, decreasing the number of mining levels, and moving toward continuous mining systems. The surface plants matched the impressive gains in the mines. We shut down leaching operations at the Iron Ore Recovery plant. Electrolytic nickel refining at Port Colborne was shutdown, and we essentially doubled the throughput of the pressure carbonyl nickel refinery in Sudbury. Inco has just completed a major modernization and automation of its Copper Refinery to bring it up to world class standards. In the smelter we have decreased the number of furnaces and converters, and streamlined operations to achieve an 80% increase in productivity and a reduction of 35% in energy consumption. With these impressive gains in place we certainly did not want to embark on an SO_2 Abatement Program that would just add on more operations, decrease productivity and increase operating costs.

While we do have a high-productivity, efficient smelter, it is not amenable to containment of SO_2 emissions. On the smelting of nickel concentrate, the 24 operating Herreshoff Roasters and the two reverberatory furnaces all produce very large volumes of gas far too dilute for efficient SO_2 capture. Capture of the high amounts of SO_2 generated in both the nickel bessemer matte converters and the copper converters is also inconceivable. The only gas that is amenable to efficient SO_2 capture is the Copper Flash Furnace gas from which we currently produce 80,000 tons per year of liquid SO_2.



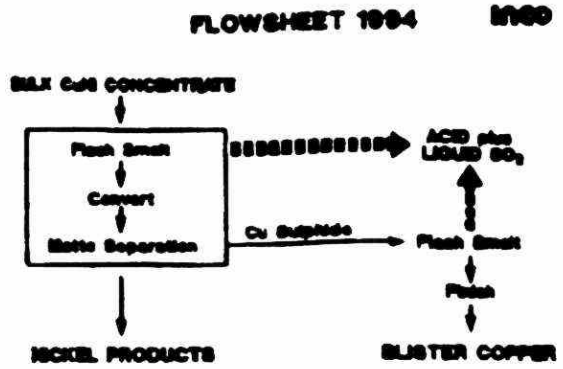
It is evident, that to capture more of the SO_2 , the smelting process had to be changed, and we have examined most of the options. Inco developed the Roast-Reduction smelting process and carried out a plant scale test in Thompson at a cost of $23 million in 1979. The reduction smelting process did achieve a high degree of SO_2 capture on nickel concentrate, but because it did not address the

copper converter gas it would not achieve the 265,000 tonne 1994 limit. The capital cost of implementing reduction smelting at Sudbury would be extremely high - over $700 million and since operating costs were also high this approach was abandoned.

Similarly if we flash smelted the nickel concentrate, we would capture the gases generated by the herreshoff roasters and reverberatory furnaces but emissions from the nickel and copper converters would exceed the limit.

In the Inco oxygen flash smelting process, dried concentrate is injected with commercial oxygen. The concentrate ignites and the heat of oxidation smelts the concentrate almost instantaneously. Because there is no nitrogen very high gas strengths, 80% SO_2 are achieved, permitting efficient gas cleaning and fixation as either liquid SO_2 or acid. Because no fuel is required, the oxygen flash smelting is the most energy efficient smelting process. Clearly we wanted to use this superior technology in our SO_2 Abatement Program.

We were therefore led to flash smelting of bulk concentrate. With bulk concentrate all of the copper and nickel are smelted together.

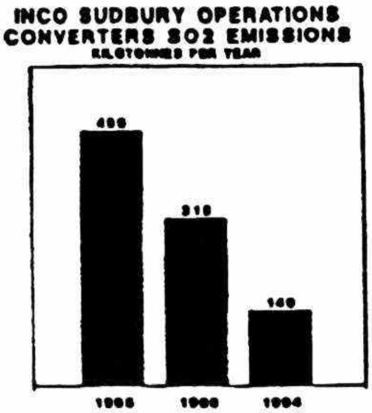


Sixty percent of the concentrate sulphur is produced in a contained high strength gas directly in the flash smelting operation.

The combined copper plus nickel furnace matte is converted to bessemer matte in the nickel converters.

The copper sulphide is separated from the nickel sulphide in the matte separation plant and iron free Cu_2S concentrate is oxygen flash smelted in a new small flash furnace; again yielding a high strength SO_2 stream. Indeed it was the development of the technology to flash smelt the Cu_2S concentrate to semi-blister without oxidizing the contained nickel that permitted us to advance the bulk smelting flowsheet.

The weak gases from the roasters and reverberatory furnaces are eliminated. Copper converting is eliminated entirely and gases from the converting operation are cut in half. Flash smelting of bulk concentrate then allows us to decrease SO_2 emissions to below the 265,000 tonne per year level by cleaning and processing only the high strength gas streams.



The Process Strategy adopted to meet the 1994 regulated emission levels is as follows: first, reject sulphur as pyrrhotite in the milling operation to decrease the amount of the sulphur going to the smelter; second, flash smelt bulk copper-nickel concentrate; carry out copper nickel separation exclusively at the Matte Separation Plant; flash smelt the iron free Cu_2S copper concentrate; and finally fix high strength flash furnace gases in a large new acid plant located at the Smelter site.

Rather than adding process equipment to reject more pyrrhotite, a major consolidation of the milling facilities is being undertaken. We will be installing at the Clarabelle Mill the large 32 foot diameter Semi-Autogenous Grinding Mill of the type shown here. The SAG Mill will handle all of the crushing and grinding operations now carried out at the Frood-Stobie Mill. Large new flotation cells, over ten times larger than the existing cells will also be installed. The first line installed, shown here, has been in operation for the past year and a half with excellent results. Five new lines of the large cells will handle all of the flotation now carried out at both the Frood-Stobie and the Clarabelle Mills, and still free half of the existing flotation lines in place. These cells will be used to replace, and expand the pyrrhotite rejection circuits currently located in the Copper Cliff Mill. Switching to bulk concentrate will eliminate the copper-nickel separation circuit in the Copper Cliff Mill. The Mills Rationalization Program will permit us to shutdown two of the Sudbury area mills and to reject additional pyrrhotite.

The cost of this Program will be $69 million dollars. The manpower, energy and reagent savings are significant and the Project will permit us to reject the equivalent of 100,000 tonnes per year of SO_2 from the Smelter.

The scope of the Smelter portion of the SO_2 Abatement Program involves construction of two new large flash smelting furnaces, each capable of smelting an average of 2,000 tons per day of concentrate. A new 500 ton per day oxygen plant will supplement the existing 1,400 ton per day oxygen plant. A new flash smelting furnace will be built for the 800 tons per day of Cu_2S concentrate. The large new acid plant will be built to handle the off-gas from both flash furnaces operating at peak design rates of 2,500 tons per day. In combination with the existing liquid SO_2 plant it will allow Inco to meet emission below the 265,000 regulated limit when suitable additional smelter gas is available.

Reduction of fugitive SO_2 emissions within the smelter will be achieved by eliminating the current copper coverter operation and by other moves now in the planning stages.

The estimated capital cost of the Smelter SO_2 Abatement Program is $425 million dollars. With the Mills Rationalization Program added, the total SO_2 Abatement Project will approach $500 million.

CAPITAL COST ESTIMATE
($ Millions)

SMELTER SO_2 ABATEMENT PROGRAM	
SMELTING	230
MATTE SEPARATION	8
GAS CLEANING & SULPHUR FIXATION	122
UTILITIES	65
SMELTER SO_2 ABATEMENT PROGRAM	425
MILLS RATIONALIZATION PROGRAM	69
SULPHUR DIOXIDE ABATEMENT PROJECT	494

The new streamlined smelter will give a 20% increase in productivity. A more significant increase will be achieved in the acid plant with the shutdown of the Iron Ore Recovery Plant pyrrhotite roasters and acid plant. The flash furnace will cut Inco's smelting energy consumption in half. Manpower, energy and supply savings, of some $46 million are projected. However, with the very high capital cost of the Smelter Program, these savings will only yield a very low rate of return.

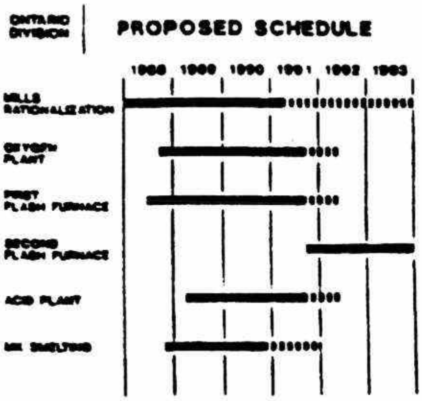
COPPER CLIFF SMELTER
-PRODUCTIVITY-
1980 - 94

	lb CuNi/manshift
1980	1440
1989 Plan	2600
1994 Projected	3030

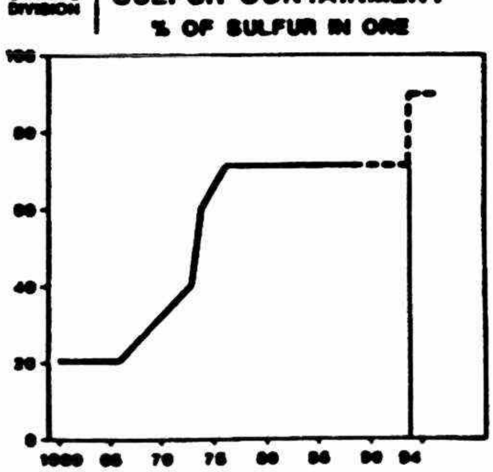
COPPER CLIFF SMELTER
-ENERGY CONSUMPTION-
1980 - 94

	BTU/lb CuNi
1980	15,500
1989 Plan	10,000
1994 Projected	4,500

The Smelter Program has a tight implementation schedule to meet the 1994 deadline. The two flash furnaces must be built sequentially to be able to carry on with production during the construction process.



The oxygen plant and the new acid plant have been scheduled to be completed at the same time as the first flash furnace, so that at some time in 1992, after we have these three major plants running, we should be able to reduce SO_2 emissions by around 100,000 tonnes a year. Most of the SO_2 reductions will start when the second flash furnace is operational and we have switched over to bulk concentrate.



In summary, Inco has developed two Major Programs that will lower SO_2 emissions to 265,000 tonnes per year by 1994. The Program in the Mills will consolidate Inco's three Sudbury Area mills into one, while providing facilities for rejecting 67% of the sulphur in the ore. In the Smelter, this bold new Program of flash smelting of bulk concentrate will implement the most energy efficient smelting process, and deliver 70% of the remaining sulphur as very high strength SO_2 gas uniquely suited to economic fixation. On completion, 90% of the sulphur in the ore mined will be fixed. The acid plant has been oversized to provide for further decreases in emissions in the years ahead.

ONTARIO HYDRO'S ACID GAS CONTROL PROGRAM

by

Dr. C. D. Burnham, Environment Director,
Ontario Hydro, Toronto, Ontario

Thank you. I'm glad to be here. Speaking to the Ontario Waste Management Conference makes me feel a bit like "the cat who came back". Back in 1976, just before I joined Ontario Hydro, I presented to this conference results of a feasibility study of energy recovery of sawmill wastes at Hearst.

But this morning I'm here to tell you about Ontario Hydro's acid gas control program. Acid gas emissions from Ontario Hydro operations reached a peak in 1982 of 531,000 tonnes. Hydro is required to reduce those emissions to 215,000 tonnes by 1994, a 60 percent reduction to be achieved in three stages by 1986, 1990, and 1994.

In other jurisdictions, the emission level and/or the technology to achieve it may be specified by government on a plant-by-plant or unit-by-unit basis. In Ontario, the regulation is quite appropriately aimed at the desired result - that is, achieving a net reduction in acid gas loadings on environmentally sensitive areas. For Ontario Hydro an annual acid gas limit for the total system has been set. How the reduction in emissions is accomplished and at which stations is Hydro's responsibility. Our goal is to meet acid gas requirements while meeting all other environmental requirements (local air quality), minimizing costs and maintaining the flexibility of the system to meet changing electricity needs of Ontario.

Today I will discuss what is involved in meeting the acid gas requirement; the options available to us for controlling acid gas; the technologies; our selection criteria; the current status of our acid gas program in the approvals process; and projected costs and expectations.

Let's begin with an overview of the challenge. At the same time as we need to lower acid gas emissions, demand for electricity is increasing. Electricity consumption has risen by an average of 5 per cent per year for the last five years. In 1988, electricity consumption rose by 6.5 per cent. Growth in demand is expected to continue to the year 2000, but, we hope, at a more modest rate with public and industry participation in energy efficiency and conservation programs. We need to emphasize the connection between energy efficiency and the environment. In the use of electricity, the old proverb "waste not, want not" gives us half the virtue; the other half is "use less, pollute less."

I realize I'm preaching to the converted this morning, but the importance of individual effort in using electricity efficiently cannot be stressed too often in our collective battle against acid gas emissions. Technologies cause acid gas emissions, but responsibility for the amount of energy used can be found at the individual, as well as the corporate level.

What is Ontario Hydro doing to reduce acid gas emissions? We have an aggressive control program to reduce the two acid gases, sulphur dioxide and nitrogen oxide, that we emit from our fossil-fuelled generating plants. The challenge is in reducing acid gas emissions with our present generating system while meeting the energy demands of Ontario. This will mean installing controls on currently operating fossil-fuelled plants, some of which have been in service since 1962.

We have six operational fossil-fuelled stations:

	Capacity	% S in fuel (1988)
Lakeview (in Mississauga)	8 x 300 MW	1.6
Lambton (near Sarnia)	4 x 500 MW	1.6
Nanticoke (near Simcoe)	8 x 500 MW	1.3
Thunder Bay	2 x 150 MW	0.4
Atikokan	1 x 200 MW	0.4
Lennox (near Kingston)	4 x 500 MW	0.6

Lennox burns oil; Thunder Bay and Atikokan, lignite; Nanticoke burns a mixture of U.S. and Canadian coal; Lakeview and Lambton burn U.S. coal. In general, the average percentage of sulphur in the coal we burn has been declining steadily since 1982, from 1.8 per cent down to 1.3 per cent in 1988. We plan to have it even lower in 1989 and 1990.

In 1988, these fossil-fuelled stations produced 25 per cent of our total energy. Nuclear, at 50 per cent, and hydraulic generation at 25 per cent produced the lowest cost energy and were therefore used as much as possible to meet Ontario's needs. Fossil is used as a "swing" fuel, to meet daily and seasonal peaks in demand which cannot be met by other lower cost fuels.

With that in mind, let's look at projections of Ontario Hydro's NOx (as NO) and SO2 emissions to the year 2000. Using the middle-range estimate for load growth or electricity consumption, emissions without added control technology would be over 400,000 tonnes. With the addition of control technologies, emissions will be less than our regulatory limit of 215,000 tonnes.

What are the options for controlling acid gas? There are four.

I. The first, reducing the use of fossil generation, does not rely entirely upon technology. Of highest priority here is energy efficiency -- the success of which depends upon people across the province, from the individual to the industrialist. Efficient use of electricity is a beneficial option for reducing the use of fossil generation (and thus reducing acid gas) because it is not a remedial measure that introduces new problems, but a preventive, and relatively "clean" one.

In 1988 our Marketing Branch shifted its focus to become the Energy Management Branch, and launched a number of programs and initiatives that work toward energy efficiency across the province. These programs include information-based conservation, such as consultation on how homes and businesses can use electricity more efficiently; incentives that encourage the use of high efficiency motors and street lighting, or energy monitoring equipment; and "load shifting" or encouraging our customers to use electricity during off-peak nighttime hours.

Our target under these energy management programs is 4500 megawatts (MW) of electrical capacity that won't have to be available from our fossil or other generating stations by the year 2000. 1500 MW will come from market driven efficiency improvements, 2000 MW from incentive driven efficiency improvements and 1000 MW from load shifting.

In addition to these energy efficiency measures, the other fossil-reducing options are the use of nuclear and hydraulic generation, parallel or private small generation (non-utility generation), and purchasing more power while selling less. Current plans include: 1100 MW new hydraulic capacity and; 1000 MW non-utility generation capacity by the year 2000. New nuclear generation could not be available until after the year 2000.

II. The second option in reducing acid gas emissions is the reduction of sulphur in the fuel through the use of washed low sulphur coal, purchase of coals containing less sulphur, and use of alternate low sulphur fossil fuels such as oil and natural gas. Ontario Hydro has bought primarily washed coal for the past two decades. Physical washing is capable of removing 10 to 25 per cent of the total sulphur from the coal. Since the late 1970s, we have also been buying increasingly lower sulphur coal to reduce acid gas emissions and improve local air quality.

Burning low sulphur coal brings a mixed blessing. It reduces SO_2 emissions but our major coal-fired stations were not designed to burn low sulphur coal. Since the resistivity of the ash changes with low sulphur coal, the electrostatic precipitators are less efficient in removing fly ash from flue gases so that particulate emissions and opacity increase. We are preparing to modify Lakeview, Lambton and Nanticoke by installing flue gas conditioning systems (SO_3 and NH_3) that will maintain precipitator performance and will allow us to burn lower sulphur coal (down to < 1 per cent) to see us through until the first scrubber units are installed in 1994.

Lennox TGS, our only oil-fired station has recently been recommissioned and burns low sulphur oil. RL Hearn TGS, our only natural gas fired station, is presently not in service. The feasibility of recommissioning it on natural gas is being studied.

III. The third option is to install clean coal technology, such as integrated gasification combined cycle or fluidized bed technology. These new lower emission coal technologies are developing technologies which are alternatives being considered for generation after the year 2000.

IV. And the fourth option is to retrofit our fossil stations with flue gas desulphurization (FGD) and/or NOx control technologies. This option is the one that I plan to present in detail today.

Now let's turn to the control equipment options for reducing acid gas. First, SO2 control through retrofitting of flue-gas desulphurization (FGD) equipment.

Flue-Gas Desulphurization (FGD)/Scrubbers

The flue-gas desulphurization component of Ontario Hydro's acid gas control program will involve FGD equipment on selected, existing coal-fired generating stations during the period 1994 to 2010. Based on the most probable load growth forecast of 2.6 per cent, compliance will require a reduction in acid gas emissions equal to that achieved by retrofitting eight 500 megawatt units with 90 per cent efficient FGD equipment through the period 1994 to 2000. Burning lower sulphur coal would not reduce SO2 emissions enough to meet the 1994 acid gas limits.

Hydro has conducted a preliminary screening of candidate FGD processes. Selection criteria included: maturity of the developed process; the experience of other utilities with the processes; technical risk; reliability; the introduction of secondary environmental impacts; and finally, life cycle costs.

Those FGD processes which met these criteria and were selected for further detailed study included:

- Wet limestone scrubbing
- Lime Spray Dry Scrubbing
- Limestone Dual Alkali Scrubbing; and
- Sorbent Furnace Injection Scrubbing.

Each process has its own set of advantages and disadvantages that will influence application at specific sites. Detailed evaluation studies are in progress to identify the best processes for each site and to obtain Environmental Assessment (EA) approval for a program of installing any of the four candidate technologies on any of three sites. An EA document has already been submitted to the Minister of the Environment for approval.

Wet Limestone Slurry (WLS)

The Wet Limestone Slurry Process is the most widely applied flue gas scrubbing process. The lime slurry process is a very similar process. Together, these two processes represent approximately 80 percent (or about 42,000 MW) of scrubbing units currently installed by electrical utilities in the U.S. The limestone slurry process is often considered the standard of comparison for new technologies, and is capable of achieving up to 96 per cent removal of the sulphur dioxide in the flue gas.

The WLS process (Figure 1) uses limestone as the scrubbing reagent to remove sulphur dioxide (SO2) from flue gas. Limestone is delivered to the generating station site and stockpiled. It is taken from the stockpile to a ball mill where it is ground and mixed with water to form a slurry. This slurry is stored in tanks and pumped to the scrubber units as required.

Sulphur dioxide removal takes place downstream of the boiler after particulate collection. As the flue gas enters the scrubber vessel it contacts a limestone slurry being sprayed into the passing gas flow. The limestone slurry reacts with the SO2 in the flue gas to form a waste by-product consisting mainly of calcium salts, with some fly ash and unreacted limestone reagent.

New stacks are required to accommodate the wet post-scrubber gases. Waste by-products leave the scrubber in a fluid stream and can either be pumped to a settling pond or processed for landfill disposal.

Wastes from the WLS process can be used for various constructive purposes. The gypsum can be used to produce commercial quality wallboard and has been produced in Germany, Japan and some in the U.S.

ADVANTAGES:

- uses a comparatively inexpensive and abundant scrubbing reagent -- limestone;
- extensive operating experience in utility industry;
- proven reliability and availability; and
- can produce wallboard-quality gypsum.

DISADVANTAGES:

- high capital costs;
- high operating costs due to large quantities of reagent required and a need for frequent maintenance;
- occasional process water discharges may be required to maintain optimal process operation; and
- produces a wet, highly visible plume leaving the chimney that could contribute to some local increases in fog and ground-level icing.
- large waste piles

Limestone Dual Alkali Process (LSDA)

The LSDA process (Figure 2) is a wet slurry, regenerative process. The process uses a clear sodium sulphite/bisulphite solution to react with SO2 in the scrubber. After particulate collection, flue gas passes into the scrubber towers where the sulphur dioxide is removed by a sodium scrubbing solution. New stacks are required to accommodate the wet post-scrubber gases.

Limestone is pulverized in a ball mill and then mixed with water to make slurry, which is pumped to a reaction tank in the scrubber building. The spent scrubbing solution is then drained to a tank where it reacts with a limestone slurry to regenerate the sodium sulphite solution. In the regeneration process, a mixture of calcium sulphite/sulphate solids form. These insoluble calcium salts are removed from the scrubbing solution by settling in a thickener. This is followed by vacuum filtering where a filter cake is formed and washed with fresh water. The wash water from the filter and clarified liquid from the thickener are stored in an overflow tank for reuse in the scrubber.

After dewatering, waste from the filter is carried by conveyor to a mixer where it is combined with fly ash and lime and then moved to a temporary storage pile. The processed waste is eventually transported to a landfill site. An important point to note is that this process can also produce commercial quality wallboard gypsum by putting an oxidizing refinery on the backend.

Currently, there are no utility installations in the US using a LSDA process, although there has been extensive testing in the laboratory and at the pilot scale. There are 6 units in U.S. with lime regeneration.

Processed waste can be used for road base and backfilling applications. The limestone dual alkali system also permits production of a usable gypsum product, but it is more costly than landfilling.

ADVANTAGES:

- lower maintenance requirement because the reduced potential for scaling and plugging inside the absorber reduces maintenance costs and increases availability;
- maintenance of a high SO2 removal efficiency (greater than 90 percent) over a wide range of coal types with varying sulphur contents;
- designed to operate with no liquid waste being discharged on a regular or continuous basis to the environment;
- lower operating costs due to reduced maintenance requirements and lower power consumption;
- improved ability to adjust system operation to respond to changes in station output; and
- capable of producing commercial quality wallboard gypsum; and

DISADVANTAGES:

- the need to purchase and store an extra scrubbing reagent (soda ash) increases costs; and
- waste material contains soluble sodium salts which may require lining of a landfill area for certain soil types.

Lime Spray Dryer Process (LSD)

The LSD process (Figure 3) is a dry scrubbing system. Lime reagent is delivered to the site and stored in silos. Lime from the silos is mixed with water to form a slurry and is pumped to a series of tanks, where the slurry flows by gravity to the atomizer or sprayer.

All the flue gas from the boiler enters the spray dryer scrubber through a common distribution point and passes directly into the spray dryer modules. The spray drying scrubber equipment is designed to spray the lime slurry into the gas flow. The water content of the slurry feeding the sprayer is controlled so that all of the water evaporates. Mixed calcium salts and fly ash entrained in the flue gas leave the spray dryer as dry particulate matter which is collected in an electrostatic precipitator (ESP) or baghouse. The cleaned flue gas is vented to the existing stack.
The particulate from the ESP, or baghouse drops into hoppers and conveyors move it to waste storage silos. Water is added to the waste from the storage silo, to minimize dust problems and optimize compaction, before it is transported to the landfill for disposal. Some waste is mixed with makeup water and recycled to the spray dryers.

Utilization options for lime spray dryer wastes are similar to those currently being used for fly ash. Most waste applications to date use the waste as backfill or landfill.

ADVANTAGES:

- reduced maintenance costs;
- reduced potential for equipment erosion, corrosion and scaling problems;
- elimination of waste water management problems;
- elimination of the need for new chimneys; and
- simplified waste handling and disposal.

DISADVANTAGES:

- lower SO2 removal efficiency;
- less commercial operating experience, particularly on high sulphur coals;
- requires a higher cost scrubbing reagent (lime); and
- higher capital costs.

Sorbent Furnace Injection (SFI)

SFI is a dry process (Figure 4) that absorbs SO2 in the boiler instead of in specially designed scrubber equipment. Tests carried out at Lakeview have achieved about 40 percent SO2 removal with limestone injection and 50 percent with hydrated lime injection.

Finely ground limestone (or hydrated lime) is injected into the boiler through nozzles which distribute it into the combustion gases. Sulphur dioxide combines with the injected material to form calcium sulphate and sulphite which are carried in the flue gas and collected downstream to the boiler. Cleaned flue gas will be exhausted through the existing chimneys.

SFI process waste is a fine dry powder consisting of fly ash, calcium sulphate and sulphite salts and unreacted limestone or lime. It will be collected in an ESP, conveyed to a storage silo and then to landfill. Before the waste can be landfilled, it must be wetted to control dusting and promote compaction of the waste. When water is mixed with this waste, the high lime content causes a reaction in which substantial heat is released in the form of steam. Handling of this waste will likely involve transporting the dry waste by enclosed vehicles to a landfill where it would be mixed with water and spread in layers to allow release of the heat contained in the waste.

Sorbent furnace injection waste is particularly suited to mine backfill because it causes a drying reaction that stabilizes and neutralizes the mine tailings.

ADVANTAGES:

- it can be installed and operating in about half the time of conventional high efficiency scrubbers; and
- it has lower capital costs because scrubbing takes place in the boiler and not specially designed scrubber equipment.

DISADVANTAGES:

- lack of utility commercial operating experience;
- achieves only about 50 percent SO2 removal efficiency;
- higher relative operating costs (reagent and waste handling costs); and
- wastes may require specialized handling because of the high lime content.

Any of these FGD options constitutes a major change to our existing generating stations, and thus requires Ontario Government approval under the Environmental Assessment Act (EA Act). Hydro is now approaching the end of a three-year program to secure EA Act approval for FGD. In order to satisfy requirements under the Act, Ontario Hydro prepared and submitted to the Ontario Ministry of the Environment (MOE) an Environmental Assessment (EA).

The FGD EA assessed the environmental implications of installing any one of four candidate technologies at any one of the three sites (i.e., Lambton, Nanticoke, Lakeview) and demonstrates the environmental acceptability of each process at each site. It requires that a Project Implementation Report (PIR) be filed with the MOE for each process application at each site. Waste management considerations were a particularly important part of this assessment. The ability of each process to produce marketable by-products and the land requirements for waste disposal if it cannot be marketed were assessed. As an example - the maximum waste disposal area requirements for each process if installed on all four units at Lambton TGS would be:

- Wet limestone slurry - 123 hectares
- Limestone dual alkali - 105 hectares
- Lime spray dryer - 112 hectares
- Sorbent furnace injections - 132 hectares

Hydro submitted the FGD EA to the Minister of the Environment in February, 1988. On November 30, 1988, we received notification of completion of government review and comment. A period of public review of 45 days then followed, ending on January 9, 1989. Five parties expressed concerns. The concerns included such issues as gypsum production, restricted limestone injection use, reheat of flue gases and closed water loop. Some of these concerns are still outstanding and will be resolved through the Conditions of Approval or in the Project Implementation Report.

On May 19, 1989, following the review period and some negotiation with interested parties, the Minister accepted the FGD EA document and recommended that no public hearing was necessary for the program. Acceptance of the EA document began another review period, which should end June 16, 1989. This second review period provides an opportunity for parties who previously commented on the FGD EA to review the Notice of Acceptance and to again request a hearing as well as provide input on any Conditions of Approval. If no request for a hearing is received the Minister will, subject to the approval of the Lieutenant-Governor-in-Council, give Notice of Approval to proceed with the undertaking. This will give Ontario Hydro the ability to choose any one of the approved options, subject to any Conditions of Approval as specified by the Minister of the Environment.

As part of the EA Act approval, FGD projects under the FGD program will require that Ontario Hydro file with the MOE a site-specific Project Implementation Report

(PIR) and obtain specific construction and operating permits and licenses under any other relevant environmental legislation, such as the Environmental Protection Act. The PIR will specify site-specific mitigation and/or monitoring commitments for each FGD installation.

NOx Control

Now let us turn to emission control equipment for NOx. In the past two decades, Hydro has been implementing options to limit nitrogen oxides emissions (NOx) from utility boilers. To date, our approaches have involved combustion controls, whereby furnace, burner and flame geometries are designed to limit the formation of NOx in the high temperature flame zones. A variety of in-furnace techniques are available for boilers, including Low NOx Burners and Water/Steam Injection.

The use of post-combustion NOx control strategies generally offer the advantage of a higher potential of NOx reduction than currently available with combustion controls. Post-combustion controls, such as Selective Non-Catalytic Reduction (SNR), and Selective Catalytic Reduction (SCR), are implemented downstream of the furnace, and generally involve methods to treat the flue gases by chemical means.

Low NOx Burners

Low NOx burners have been installed on all units at Ontario Hydro's 4000 MW Nanticoke Thermal Generating Station. Installation was completed in 1987.

Low NOx burner systems are commercially available for retrofitting on both front-wall and tangentially-fired boilers. With front-wall burners, the coal carrying air is controlled to provide reducing conditions in the early part of the flame. The balance of the combustion air is injected as secondary and tertiary air to burn out smoke and char after NO formation has been suppressed.

In tangential systems, the secondary air entry is offset to form an air rich envelope around an inner fuel rich core. Tertiary air is injected into the upper furnace to complete fuel combustion.

These systems allow us to meet the requirements of current acid gas limits. Further NOx reductions will likely be required to meet acid gas limits in 1994 and beyond.

Selective Catalytic Reduction (SCR)

SCR has been commercially demonstrated in Japan and Western Europe. In the United States, there is only limited experience with SCR and only pilot plant experience on coal.

SCR can reduce emissions by as much as 85 percent through the injection of anhydrous ammonia (NH3) into the flue gas after the boiler economizer. The NH3 reacts with the NOx in the presence of catalyst (platinum, vanadium or titanium) at reaction temperatures ranging between 300C and 400C for low and medium sulphur coal applications. For high sulphur coals emitting more than 2000 parts per million of

SO2, a reaction temperature ranging form 350C to 400C is required to prevent catalyst poisoning. Ammonia reacts with NOx, forming water and nitrogen as the products.

Selective Non-catalytic Reduction (SNR)

Pilot studies indicate that more than 80 percent of NOx could be removed by SNR, which makes it competitive with SCR in achieving NOx reduction. SNR also requires little retrofit equipment and no catalyst, resulting in a capital cost much lower than SCR.

The SNR process injects ammonia, urea or other nitrogen-containing compounds into the flue gas in a temperature regime of 900C to 1100C, reducing NOx to water and nitrogen. The potential injection location is the upper portion of the furnace. Enhancer chemicals are sometimes used in expanding this temperature range. A test program at an Ontario Hydro location is being planned for 1990.

That will give you a picture of the options and technologies for acid gas reduction at existing Ontario Hydro coal-fired stations. Let me conclude with costs and expectations.

Electricity Price Implications of Acid Gas Control

Ontario Hydro will make the substantial financial commitment required to reduce acid gas emissions. A substantial investment has already been made. More will be made in the future. We support the principle of sustainable development and we understand the urgent need for both remedial and preventive measures.

Technologies such as flue gas desulphurization (FGD), and NOx control are solely to reduce acid gas emissions. Flue gas conditioning (FGC) allows lower sulphur coal to be burned while maintaining precipitator performance. The full cost of these technologies is included in our acid gas control program.

Some costs, primarily the use of low sulphur coal through the 1980s, are partially for emission control and partially for reasons of fuel diversity and local air quality. The premiums paid for low sulphur fuel in the late 1980s are not considered part of acid gas control program costs. In the early 1990s, fuel sulphur levels are primarily set by acid gas control requirements and are considered control program costs.

Energy management, additional non-utility generation, new hydraulic and nuclear generation and new clean fossil generation are added primarily to meet the capacity and energy needs of electricity customers. These resources also have indirect benefits of acid gas control. However, because this is an indirect benefit, the cost of these resources is not included in the acid gas control program costs.

Expenditures to date (1988)

Table 1 presents expenditures to date (to December 1988) on the acid gas control program. These have totalled $32.4 million. The largest component of this has been for low NOx burners at Nanticoke, followed by limestone injection scrubber testing at

Lakeview, control actions taken in 1988 and seeking approval for scrubbers. The annual costs have not yet had a significant impact on the price of electricity.

TABLE 1: Control Expenditures to Date
(to December 1988)

($ MILLIONS)

PRIMARILY FOR ACID GAS CONTROLS	Total
Low NOx Burners at Nanticoke	11.5
Limestone Injection Testing	7.3
Environmental Assessment for FGD	4.4
Flue Gas Conditioning Test - Lambton	0.6
Flue Gas Conditioning Test - Nanticoke	1.4
Research and Development	1.2
1988 Control Actions	6.0
Annual Expenditures	32.4
PARTIALLY FOR ACID GAS CONTROL	
Low Sulphur Coal Premiums	345

Premiums paid for low sulphur coal have been between $80 million and $95 million per year, totalling $345 million, over the period 1985-1988. Some of this is attributable to acid gas control but has not been included in the total program costs.

Future Expenditures

The financial implications of future expenditures are presented below.
The plan is to have flue gas conditioning systems operating on 12 units by 1990, flue gas desulphurization on 8 units by 2000 and NOx controls on 8 units by 2000. The total estimated capital and operating, maintenance and administration costs to the year 2000 for this program are detailed in Table 2 in dollars of the year. On a cumulative basis the costs will total $2.46 billion by the year 2000, in dollars of the year. Over this time period average impact on the price of electricity will be 1.8 per cent with a maximum of 2.9 per cent in 1998.

TABLE 2
Electricity Price Implications of Future Expenditures
(1989-2000)

($ MILLIONS of Year Spent)

	TOTAL
CAPITAL	
Flue Gas Conditioning	48.0
Flue Gas Desulphurization	1262.1
NOx	146.5
TOTAL	1456.7
OM&A	
Flue Gas Conditioning	56.9
Flue Gas Desulphurization	339.6
NOx	
TOTAL	396.5
Fuel Premium	607.2
TOTAL ANNUAL COST	2460.4
Average Price Impact Per Cent	1.8

The acid gas reduction program, as my talk has indicated, is an enormous and expensive undertaking, but one that is a high priority on our Corporate agenda. By 1994 we will have more than halved our acid gas emissions from the peak in the early 1980s. Up to 1990, the price of electricity is estimated to rise 0.5 per cent, and by 1998, by 2.9 per cent to pay for our acid gas reductions. Thus the price of electricity will be affected, but we know from listening that people in Ontario are willing to pay more for cleaner air. Indeed in the long term, it is a small price to pay.

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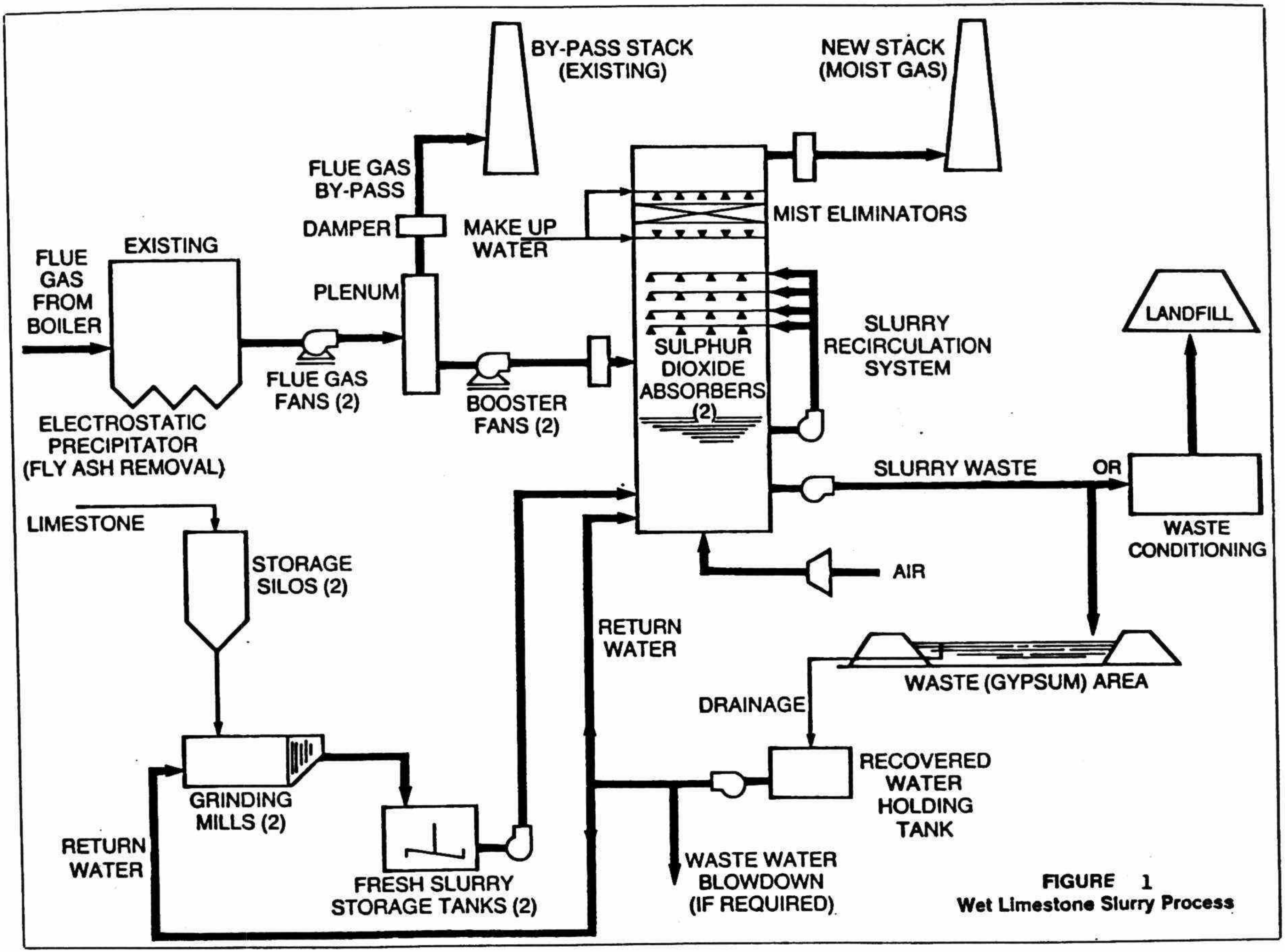

FIGURE 1
Wet Limestone Slurry Process

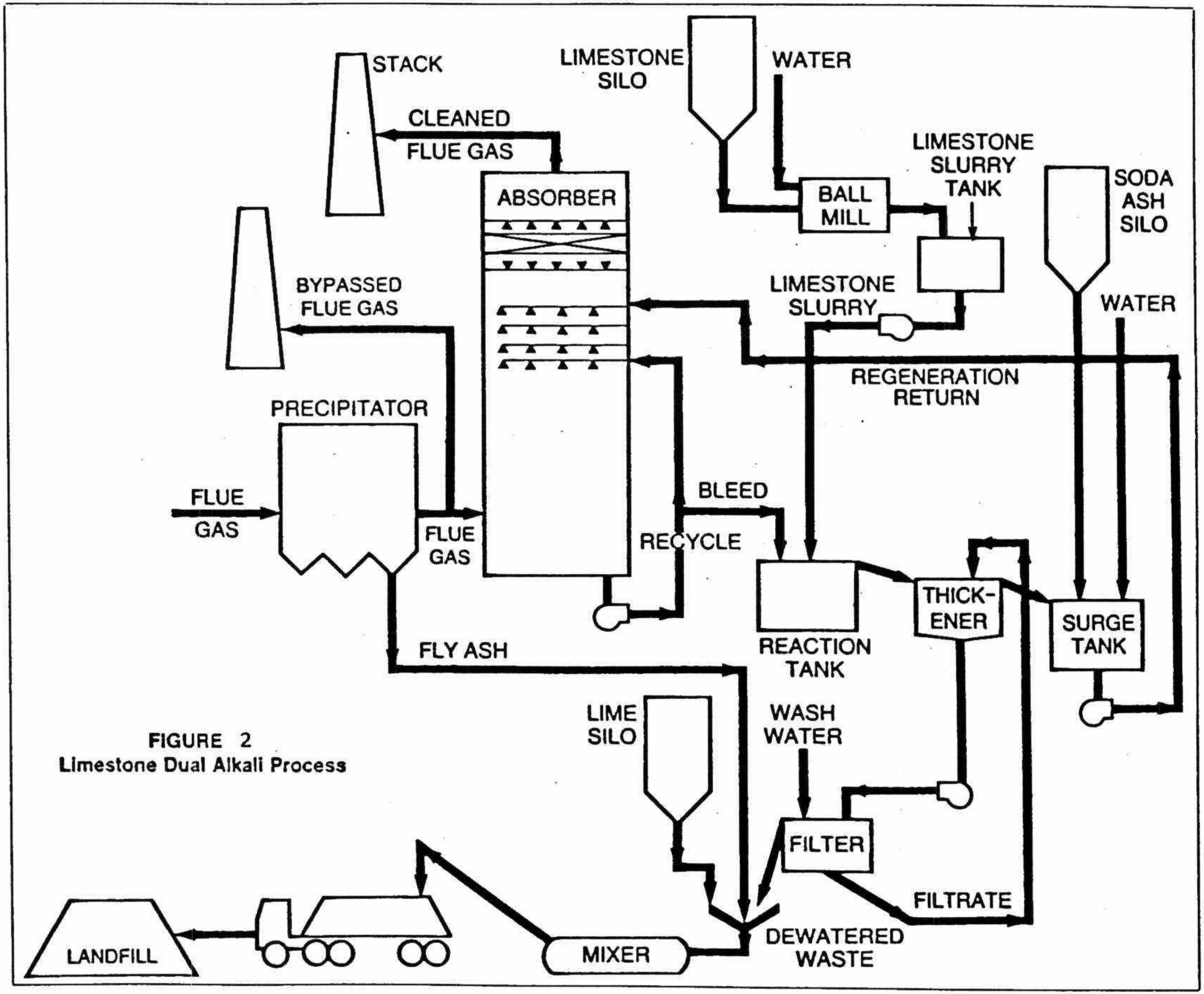

FIGURE 2
Limestone Dual Alkali Process

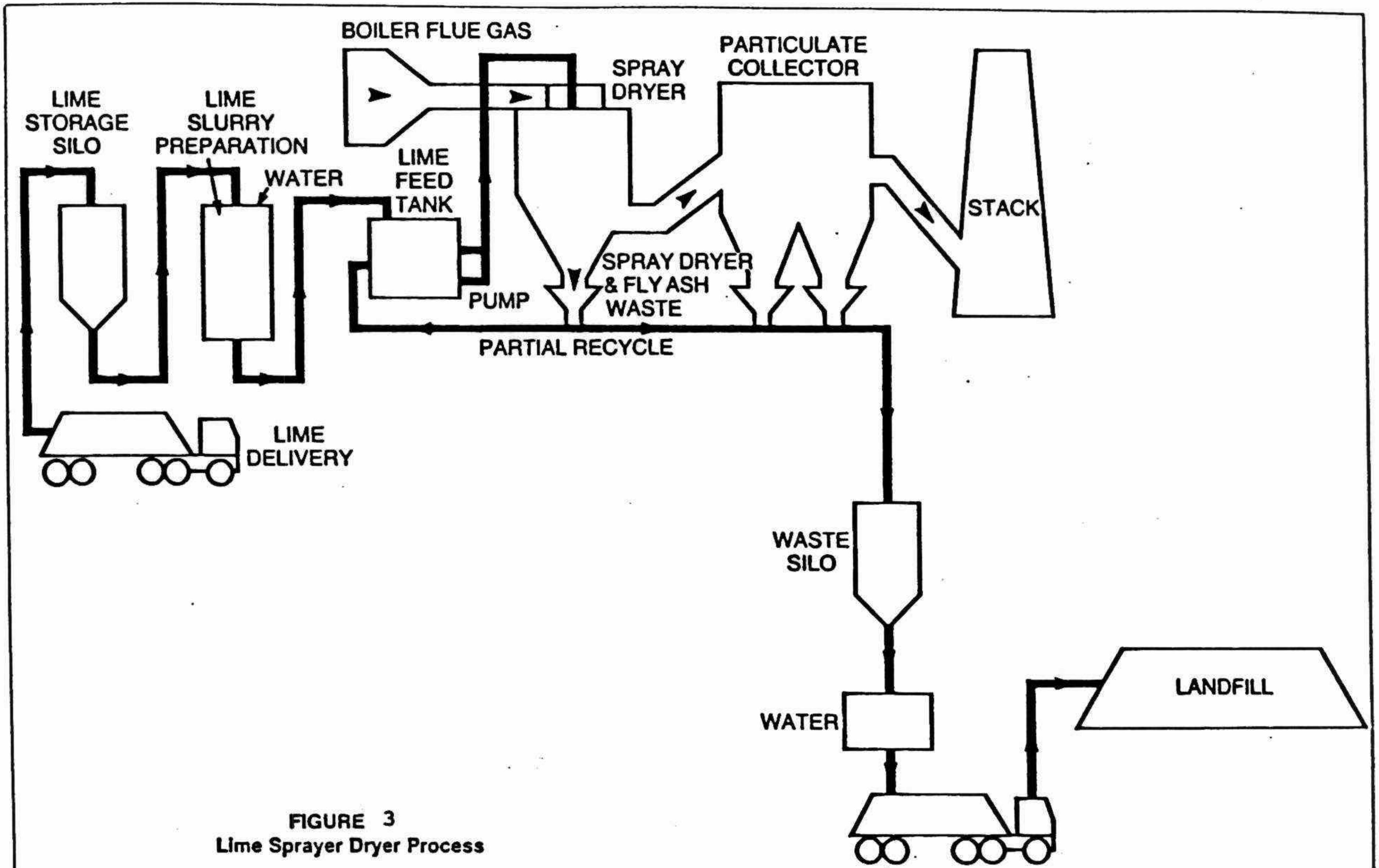

FIGURE 3
Lime Sprayer Dryer Process

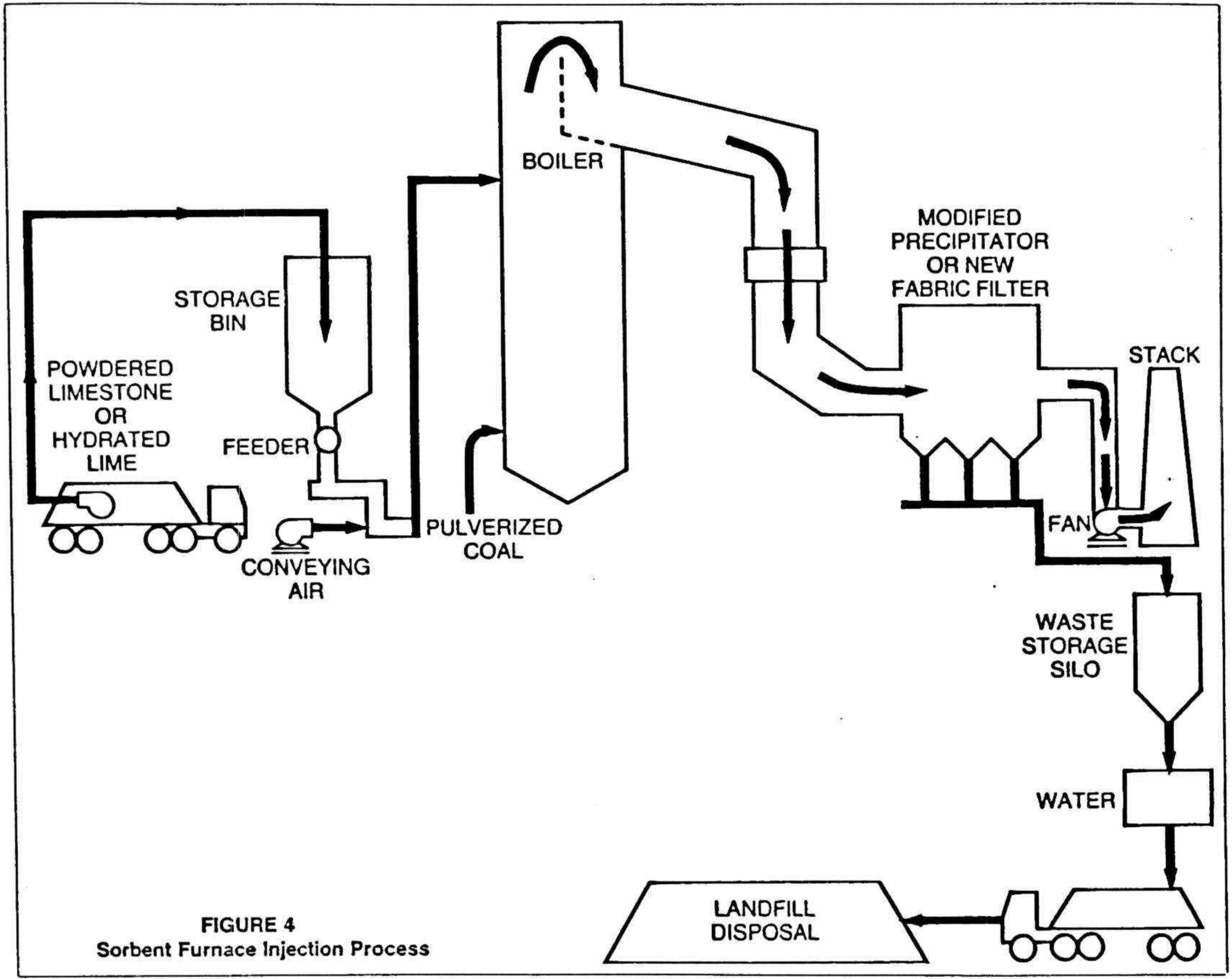

FIGURE 4
Sorbent Furnace Injection Process

BIOMEDICAL WASTE INCINERATION

by

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The management of biomedical waste has been an ongoing issue in Ontario for a number of years, whereas other jurisdictions have only recently begun to appreciate the complexity of the proper management of this waste stream. In addition, the Ontario Ministry of the Environment has been involved in issues relating to the design and operation of incinerators for many years, having published the first of several Incinerator Criteria documents in 1974(1). However, the recent high profile of several biomedical waste incidents in other jurisdictions, along with recent public concern about the environmental impact of all incineration processes, have led to a comprehensive re-examination of the issue of biomedical waste incineration in Ontario.

This paper provide a brief description of biomedical waste (BW), a summary of BW generation rates, Ontario BW incineration issues, and features of state-of-the-art BW incinerators.

BIOMEDICAL WASTE

The 1985 amendments to the General-Waste Management Regulation (Regulation 309)(2) under the Environmental Protection Act defined pathological waste as shown in Figure 1. Since it is a hazardous waste, it requires generator registration, manifesting, and approved carriers/receivers (with certain specific exceptions). It is also subject to Waste Management System and Waste Disposal Site requirements of the Act and Regulation 309.

The primary reason for its inclusion is the long standing public health issue of transmitting infection, as well as the related issues of occupational health and general aesthetics. It is, therefore, particularly important in developing a program dealing with biomedical waste to consider the primary need to handle and dispose of materials which are contaminated or suspected to be contaminated with the causative agents of infectious disease and capable of infecting or causing disease in susceptible individuals or animals exposed to them.

The regulatory definition was supplemented in 1986 by the publication and distribution of Guidelines for the handling and disposal of biomedical waste(3). This document includes detailed definitions, packaging specifications, storage, transfer, disposal alternatives and other relevant guidance. The document was endorsed by the Interministry Task Force on

FIGURE 1 PATHOLOGICAL WASTE DEFINITION

Hazardous waste means a waste that is a:

....

ix) pathological waste

....

O.Reg. 309 1.27

Pathological waste means:

i) any part of the human body, including tissues and body fluids, but excluding fluids, extracted teeth, hair, nail clippings and the like, that are not infectious

ii) any part of the carcass of an animal infected with a communicable disease or suspected by a licenced veterinary practitioner to be infected with a communicable disease, or

iii) non-anatomical waste infected with communicable disease.

O.Reg. 309 1.49

the Handling and Disposal of Biomedical Waste, which included representatives of the Ministries of Health, Labour and Environment, hospital associations, Medical Officers of Health and local municipalities.

The classifications and packaging of biomedical waste in the Guideline are summarized in Figure 2. These classifications are primarily related to the specific requirements and special kinds of hazards presented by these wastes. The colour coding is primarily to facilitate the proper handling throughout the collection, transfer and disposal operations. The various types of BW can also have very different incineration properties (i.e. calorific and moisture content) and chemical constituents (e.g. metals, halides and organics). Consequently, the segregation and colour coding can also be used in designing and operating incineration systems.

BIOMEDICAL WASTE GENERATION RATES

Waste generation rates for biomedical waste vary considerably from hospital to hospital, and depend in part on the individual hospital's practice of using single use items. Various literature references, summarized in Figure 3(4), show that waste generation rates in Canadian and American hospitals fall into a wide range of 2 to 7.5 kg/bed/day.

A 1985 survey conducted by the Ontario Hospital Association(4) indicated that an average size Ontario Hospital generates 0.75 kg/bed/day of infectious waste for each special care patient. The 1987 Canadian Hospital Directory(5) shows that the total number of hospital beds in Ontario exceeds 60,000.

The total amount of BW produced in Ontario is less than 1% of the refuse disposed of in municipal landfills. Currently, about a quarter of this waste is disposed of at hospital incinerators, with most of the balance being exported from the province for incineration at Gatineau, Quebec or in the United States.

Recent and projected trends in the generation of BW are important in examining BW incineration in the future. Over the past several decades, there has been a very significant increase in the use of disposable and/or plastic products in health care facilities. Not only has this trend increased the total amount of waste to be disposed of, it has also changed the burning characteristics and the chemical content of the waste. The future trend in waste amounts will be influenced by two factors: the broad provincial adoption of the 4Rs (waste reduction, reuse, recycling and recovery) approach on the one hand; and issues relating to additional precautions to minimize exposure to microbiological agents (e.g. AIDS) on the other.

FIGURE 2 BIOMEDICAL WASTE PACKAGING

Waste Type	Colour Code	Packaging
Human Anatomical	Red	3 mil. double bagged
Infectious Animal Anatomical	Orange	3 mil. double bagged
Infectious Non-Anatomical	Yellow	3 mil. double bagged
Sharps	Black	Hard Shell Container 3 mil. double bagged
Non-Infectious*	Black	3 mil. double bagged

*Note: Does not include office, kitchen and mechanical plant waste.

FIGURE 3 BIOMEDICAL WASTE GENERATION RATE

SOURCE	GENERATION RATE (Kg/Bed/Day)
Royal Jubilee Hospital Survey(1980)	
- average	2.4
- minimum and peak rate	1.5 - 3.9
E. L. Pollock	
- 1968 survey	3.03
- 1974 survey	4.06
- 1975 survey	4.28
- West coast teaching hosp.	3.69
- Conclusion of Pollock	3.0 - 7.48
Airan et al	4.3 - 5.8

The potential for decreasing the amounts of biomedical waste for incineration is being examined in two Ontario demonstration projects: a general hospital is undertaking a classical 4Rs program; and a group of hospitals intend to demonstrate the use of a hammermill/disinfection system to generate a recyclable plastic. The potential for increasing waste amounts is illustrated by the very broad concepts of "universal precautions" being proposed by some health professionals.

ONTARIO BIOMEDICAL WASTE INCINERATION

Although other disposal methods have been proposed and are being assessed, the proven way of decontaminating biomedical waste is by incineration. Caution must always be exercised to ensure the effectiveness of the incineration process. A specific study (6) has indicated that the emission of micro-organisms from BW incinerators could be attributed to insufficient temperature and retention time, resulting from the following factors:

- Initial charging of incinerator before operating temperatures are achieved;
- Failure to preheat refractory lining;
- Temperature fluctuations caused by intermittent use;
- Exceeding design linear velocities, thereby reducing the retention time;
- Charging beyond incinerator capacity; and
- Excessive moisture content of the waste.

Other factors such as positioning of burners and the precision of temperature measuring devices also have a bearing on the effectiveness of the incinerator.

The 1985 Ontario regulatory amendments included a requirement for a professional assessment of the extent of compliance of existing BW incinerators with the General-Air Pollution Regulation (Regulation 308) under the Environmental Protection Act. Based on the first series of these assessments, the Ministry hired a consultant to review the status of BW incinerators in the province. The survey identified a total of 135 on-site BW incinerators, and indicated that approximately 60% of these units were deficient in some way. These results led to a multi-faceted approach to the issue of biomedical waste disposal which included:

- the publication of new Incinerator Design and Operating Criteria;

for all new incinerators which burn one or a combination of domestic, biomedical, commercial or non-hazardous solid industrial waste. In addition, the elements of this Policy are also to be considered when evaluating existing incinerators, and assessing proposals for upgrading existing units.

The major changes as compared to the Ministry's previous BW incineration criteria are a longer residence time, an emphasis on the range of operation (particularly as it applies to waste variability), and specifying automated controls, continuous monitoring systems (minimum of THC[or CO] and opacity) and performance testing.

Although these changes are significant, the companion Policy 01-03, Air Pollution Control on Incinerators (Appendix 1B) is also extremely important. This Policy states that state-of-the-art (S of A) air pollution control systems shall be installed on all new incinerators which burn the same wastes listed for Policy 01-01, and goes on to define what S of A means in terms of:

- particulate outlet concentration;
- hydrogen chloride (HCℓ) removal;
- continuous operation; and;
- performance testing and monitoring.

These requirements challenge owners, proponents, consultants and suppliers (both incinerator and air pollution control) to enter a new chapter in the destruction of biomedical waste that they may not have considered before. Clearly, our indications to date have been that representatives of all of these groups have embraced this challenge, and see an obvious business advantage in showing that they understand and can apply state-of-the-art concepts to their areas of needs and expertise.

As noted in the Policy 01-03, incineration systems which achieve the combustion and APC requirements will minimize the formation of organics including toxic chlorinated compounds, and minimize their emission into the ambient air. Control systems which achieve these requirements will also reduce the emissions of metals (including beryllium, arsenic, cadmium, chromium, mercury, nickel, lead, selenium, antimony and zinc) and metallic compounds, and acidic gases (including sulphur dioxide [SO_2], hydrogen bromide [HBr] and hydrogen fluoride [HF])'.

The review of air pollution control alternatives indicated that larger APC systems are likely to be more cost-effective (lower capital and operating costs per kg) and offer superior performance. The Ministry of the Environment is supporting a Ministry of Health consultant study to quantify capital and operating costs of a range of BW incinerator sizes to quantify the cost-effectiveness issue. If cost and

Due to the lack of emissions data on biomedical waste incinerators, the Ministry initiated a BW incinerator test program which was partially funded through our Research Advisory Committee. The incinerators selected for the first phase of the testing were representative of the newer BW incinerators in the province in terms of design, operation, and types of waste burned. To date, five such incinerators have been tested to quantify the emission levels of combustion gases, particulates and metals, and chlorinated organics as well as to examine ash quality. The Ministry expects to be in a position to release preliminary confirmed data from this phase of the program in the near future.

The second phase of this program involves testing of two BW incinerator facilities which have add-on air pollution control equipment: an Ontario hospital unit with a liquid scrubber; and a commercial facility in Quebec with a dry scrubber/ baghouse system.

The initial review of air pollution control (APC) alternatives for BW incinerators indicated that, although few units have been installed, a number of technological options appeared feasible. In parallel with this review, the Ministry established a Policy for air pollution control on domestic, commercial, and non-hazardous solid waste incinerators, which specified parameters representing state-of-the-art control for these units. Based on these developments, the Ministry intensified the review of APC alternatives for BW incinerators. This study culminated in a January 1989 revision of the Policy on Air Pollution Control on Incinerators (Appendix 1B) to include BW facilities, and provided some flexibility in assessing capabilities on the smaller units, as discussed in the following section.

STATE-OF-THE-ART BW INCINERATION

The January, 1989 Ministry Policy 01-01, Combustion in Incinerators (Appendix 1A) specifies:

- Design (1100°C) and operating (min. 1000°C) temperatures;
- Combustion air distribution;
- Residence time (min. 1 sec);
- Oxygen availability (min. 6%);
- Turbulence and mixing;
- Range of operation;
- Pressure control and emergency exhaust; and
- Control, monitoring and performance testing

for all new incinerators which burn one or a combination of domestic, biomedical, commercial or non-hazardous solid industrial waste. In addition, the elements of this Policy are also to be considered when evaluating existing incinerators, and assessing proposals for upgrading existing units.

The major changes as compared to the Ministry's previous BW incineration criteria are a longer residence time, an emphasis on the range of operation (particularly as it applies to waste variability), and specifying automated controls, continuous monitoring systems (minimum of THC[or CO] and opacity) and performance testing.

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As noted in the Policy 01-03, 'incineration systems which achieve the combustion and APC requirements will minimize the formation of organics including toxic chlorinated compounds, and minimize their emission into the ambient air. Control systems which achieve these requirements will also reduce the emissions of metals (including beryllium, arsenic, cadmium, chromium, mercury, nickel, lead, selenium, antimony and zinc) and metallic compounds, and acidic gases (including sulphur dioxide [SO_2], hydrogen bromide [HBr] and hydrogen fluoride [HF])'.

The review of air pollution control alternatives indicated that larger APC systems are likely to be more cost-effective (lower capital and operating costs per kg) and offer superior performance. The Ministry of the Environment is supporting a Ministry of Health consultant study to quantify capital and operating costs of a range of BW incinerator sizes to quantify the cost-effectiveness issue. If cost and performance are size related, we can expect to see proposals for larger multiple-user BW units. It may be worthwhile noting that the Ministry has recently received extensive documentation on a proposal for a regional commercial incinerator to be located in the golden horseshoe.

Two other state-of-the-art issues on BW incinerators are the control of liquid effluents (if a wet scrubber is to be employed) and the disposal of ash. The liquid effluent issue is encompassed in the Ministry's MISA (Municipal and Industrial Strategy for Abatement) program (since most liquid scrubber waste from BW incinerators will discharge to municipal sewers, this is a by-law issue). The Ministry is currently developing guidelines on incinerator ash sampling to facilitate comparisons to the leachate extraction limits in Regulation 309 and ensure proper management of incinerator ash.

CONCLUSION

The Ministry of the Environment is currently revisiting the issue of biomedical waste handling and disposal, which includes the sub-issue of BW incineration. The Ministry has developed a multi-faceted program which has developed new stringent state-of-the-art requirements for BW incinerators including add-on air pollution control so that proven incineration technology can be used to effectively decontaminate infectious materials without resulting in other unacceptable health risks. The technical review aspects of this program are nearing a plateau, in anticipation of a program to deliver state-of-the-art incineration facilities across the province.

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WORLD AIR QUALITY - HOW ONTARIO COMPARES

by

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The Ontario Ministry of Environment (M.O.E.) is currently operating a network of air pollution monitors throughout the Province. A brief description of the network and the air quality data provided under the the newly established Air Quality Index (AQI) Information System will be presented. The ten year trend of various air pollutants in Ontario and the comparison of air quality with various cities around the world will be presented. Finally, the cause of high ozone levels in Ontario during July 1988 will be analyzed.

M.O. E. Air Quality Monitoring Network

The Ontario Ministry of Environment air quality network has 226 continuous ambient air pollutant monitors, 44 continuous suspended particulate monitors and 185 total suspended particulate high volume sampler monitors (Table 1). These instruments are strategically deployed in major urban and suburban locations as well as at some rural sites and in areas that are sensitive to pollution impacts (Figure 1, 2, 3 and 4). Up-to-date instrumentation along with a data acquisition system were used to monitor the realtime air quality data as well as the meteorological conditions (Table 2).

The realtime air quality data are used to compute the Air Quality Index (AQI) in 33 urban centres across Ontario. The AQI began in June 1988. The pollutants, and their corresponding health impact for various index ranges are tabulated in Table 3. The distribution of the AQI for selected Ontario cities from June 1988 till present is given is Tables 4 and 5. There were no occurrences in the very poor AQI category. Only a few hours of poor AQI conditions were recorded and these were mainly due to ozone. High ozone concentrations are very dependent on the meteorological conditions. A case study will be given at the end of this paper. The air quality in Ontario was good or very good for over 90% of the time.

Ten-year Trend Air Pollutant Levels in Ontario

Ten-year trends in the annual means of various pollutants monitored in Ontario are presented in Figures 5 - 13.

The major sources of SO_2 emitted in Ontario are smelters and electric utilities with minor contribution from petroleum refineries, pulp and paper mills etc.. Over the past 10 years, there has been approximately a 60% reduction in the ambient SO_2 level as a result of tighter industrial emission controls (Figure 5).

The main sources of total reduced sulphur are steel manufacturing, pulp and paper mills and refineries. MOE's monitors are located near large point sources of total reduced sulphur. The trend shows that the minimum annual mean was in 1985 with a slow increase in recent years (Figure 6).

In Figure 7, the ambient carbon monoxide level has decreased by about 50% over the past ten years. This is mainly due to the tighter control on automotive emissions.

The ambient hydrocarbon levels for the past ten years (Figure 8) has been relatively constant. Methane is the primary component with a small fraction of non-methane hydrocarbons which reacts with oxides of nitrogen in the presecne of sunlight to form ozone.

The anthrogenic sources of oxides of nitrogen are automobiles, power plants, incinerators and chemical processes which involve high temperature combustion. There is a slight overall improvement of the ambient levels (Figure 9).

Ozone is the major component of photochemical oxidant compounds. It is formed from the reaction between hydrocarbons and oxides of nitrogen in the presence of sunlight. Maximum concentrations are often found downwind of the sources of hydrocarbons and oxides of nitrogen. The provincial ozone trend (Figure 10) has remained relatively constant despite some variation at specific sites.

Total suspended particulate include soil dust, vehicle exhaust particulates, atmospheric aerosal (SO_4,NO_3), emission from industry etc. The size range is from 0.1 to 100 microns in diameter. Daily samples are collected and analyzed. The ten-year trend (Figure 11) has shown a 15% improvement of the total suspended particulate in Ontario.

In Figure 12, the suspended particles (SP) as measured in Coefficient of Haze units has remained relatively constant over the past ten years. Since this instrument measures the reduction in transmitted light through a filter which collects particulate matter, it is not an exact measure of the concentration of particulates.

Lead in suspended particulate has significantly decreased with the introduction of lead-free gasoline (Figure 13). With the eventual attrition of the automobile operated on leaded gasoline, there will be a gradual decrease in the ambient lead level in Ontario.

How Air Quality of cities in Ontario Compare with Other Cities Around the World

Using air quality data as compiled by the World Health Organization, United Nations Environment Program, Global Environment Monitoring System in 1988⁽¹⁾, air quality of a few cities in Ontario were compared with various cities around the world. Comparison are made according to selected pollutants (Figure 14 - 18).

There was a overall decline in the SO_2 levels with time in most major urban areas around the world. Better emission control, relocation of power plants and industries, tall stacks for wider dispersion of emission and environmental control legislative activities have led to the reduction of SO_2 levels in the urban areas. Toronto and Hamilton are significantly better than the other urban centres in the study (Figure 14).

Motor vehicle emissions accounted for almost all of the carbon monoxide emission (Figure 16). While there is a progressive reduction of carbon monoxide in the ambient air, the problem is far from being solved. The annual average level of carbon monoxide in Toronto and Hamilton were about one part per million. These concentrations depend strongly on the location of the monitors. This was very low when considering the number of vehicles and the mode of operation of the vehicles by the population.

The airborne particles including combustion products, dust, fly ash, sulphate, nitrate and pollen are measured as total suspended particulate. Natural sources include plant pollen, wind-blown dust and forest fires.The annual mean total suspended particulate measurement of various cities worldwide is given in Figure 17. Toronto and Hamilton are among the better half of the highly populated cities.

A significant portion of the lead in suspended particulate orginated from the internal combustion of lead additives in gasoline. The smelting of lead, battery manufacturng, metal production and fabrication are also major sources of lead emissions. Despite the fact that Hamilton has a few metal production plants, the concentration of lead is still significantly lower than that of a few cities around the world (Figure 18).

High Ozone Episode on July 3-10, 1988

Ozone and suspended particulate are the two major air pollutants that affect the air quality in Ontario during the summer season. The prevailing light southerly to southwesterly synoptic flows associated with the back of a large area of high pressure covering Southern Ontario will provide favorable conditions for the photochemical reactions of the precursors namely, nitrogen dioxide and hydrocarbon to form ozone. The combination of long range transport of the precursors together with local Ontario emissions will cause high ozone levels in Southern Ontario.

During the period July 3-10, 1988(2), record high ozone concentrations were monitored in many locations in Southern Ontario (Figure 19,20,21). An episode is defined as the occurence of high ozone levels (greater than 80 ppb) in a few areas simultaneously. In the three figures, the diurnal pattern over the five days is typical of the photochemical nature of the ozone formation in ambient air. The concentration of ozone is highly dependent on the amount of sunlight for a given concentration of the precursors. The ozone concentration is highest in the mid-afternoon and lowest during the early morning.

There was less diurnal variation of the ozone concentration at CN Tower (440 M) (Figure 20). This indicated that there was a transport of ozone aloft and during the night, it was decoupled from the surface by the nocturnal inversion. The ozone concentration aloft was substantially higher than that at the surface.

The diurnal variation of the ozone concentration at Long Point, a rural area southwest of Toronto on Lake Erie, was much less that Toronto (Figure 21). This was due to the lack of nitric oxide in the ambient air to scavenge the ozone.

With reference to long range transport of pollutants, the back trajectory analysis for July 5,6, and 7 showed an airflow from the southwest. During this time period Windsor and Toledo showed ozone concentration of a similar magnitude and diurnal pattern. This is consistent with the two cities being subjected to the same air mass. From July 8 to July 10, the back trajectory changed from southwest to the west. The overall ozone concentrations in Southern Ontario slowly decreased.

Conclusion

The air quality in Ontario has shown improvement for sulfur dioxide, carbon monoxide, total suspended particulate and lead, with little change in hydrocarbon levels, ozone and nitrogen oxides over the past 10 years. Our densely populated cities, Toronto and Hamilton are among the cleanest of a group of cities around the world which have similar population and activities. The cooperation and the joint effort of the public, the industries and different levels of Government has contributed to the success of creating a cleaner environment. With more environmental protection activities implemented and planned for the future, Ontario will be a better place in which to live.

References

[1] Meeting Of UNEP/WHO Government Experts On Health-Related Environmental Monitoring Geneva, 12-17 September 1988

[2] The Impact Of Long Range Transport Of Oxidant Levels - The Southern Ontario Situation, by J.Kurtz, D. Yap, R. Bloxam, L. Shenfeld, P.Kiely

M.O.E. AIR QUALITY NETWORK INVENTORY (1988)

	SO_2	TRS	O_3	NO_2	CO	TSP	HC	SP
MONITOR LABS	42	26	9	22	-	-	-	-
TECO	28	1	13	14	10	-	-	-
DASIBI	3	2	3	-	-	-	-	-
BENDIX	-	-	20	-	20	-	3	-
BECKMAN	-	-	-	-	-	-	10	-
GMW	-	-	-	-	-	185	-	-
ARB	-	-	-	-	-	-	-	44
TOTAL:	73	29	45	36	30	185	13	44

Table 1

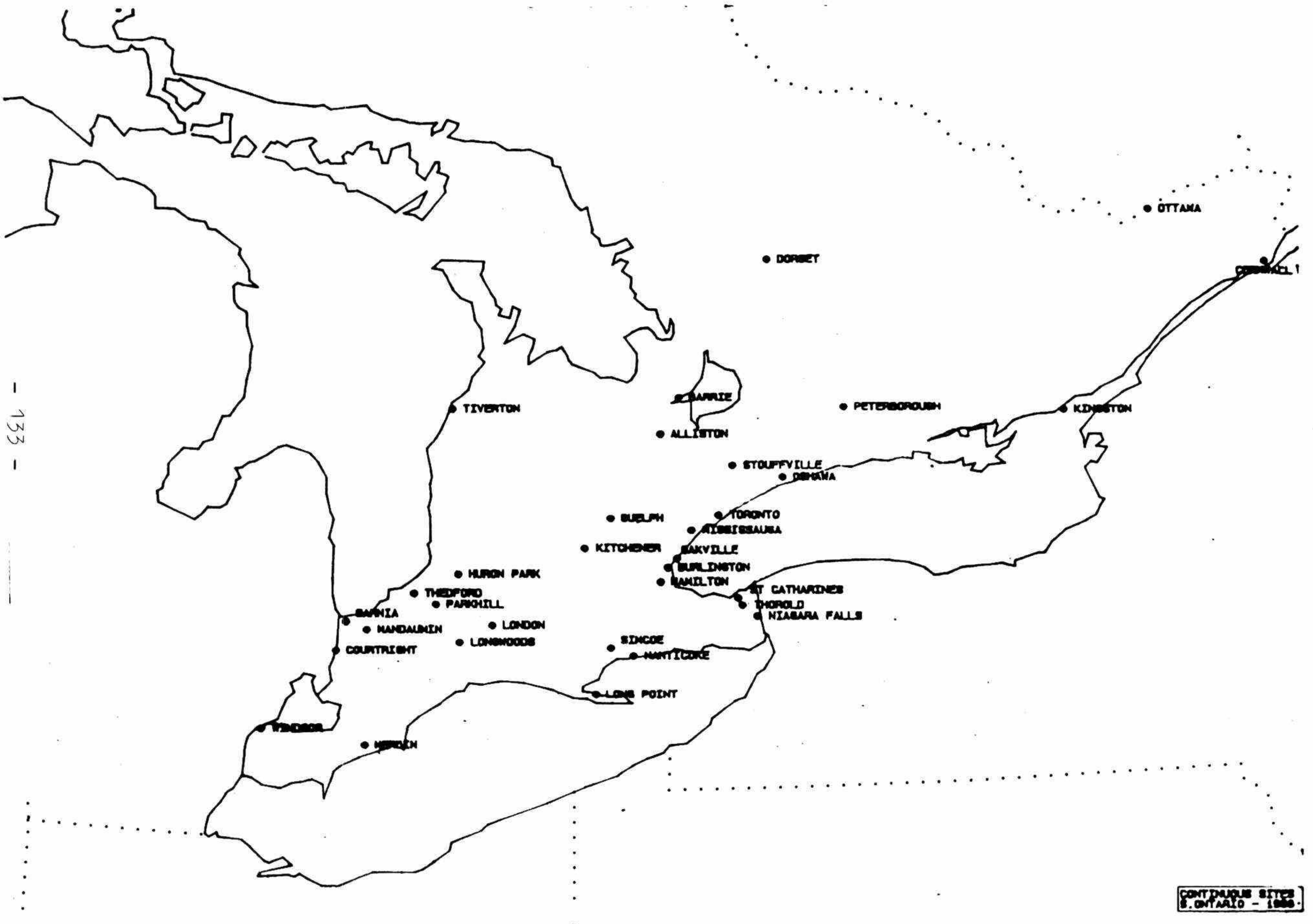

OTTAWA
DORSET
CORNWALL 1
BARRIE
TIVERTON
PETERBOROUGH
KINGSTON
ALLISTON
STOUFFVILLE
OSHAWA
GUELPH
TORONTO
MISSISSAUGA
KITCHENER
OAKVILLE
BURLINGTON
HURON PARK
HAMILTON
THEDFORD
ST CATHARINES
PARKHILL
THOROLD
SARNIA
NIAGARA FALLS
MANDAUMIN
LONDON
COURTRIGHT
LONGWOODS
SIMCOE
NANTICOKE
LONG POINT
WINDSOR
MERLIN
CONTINUOUS SITES
S.ONTARIO - 19

Figure 1

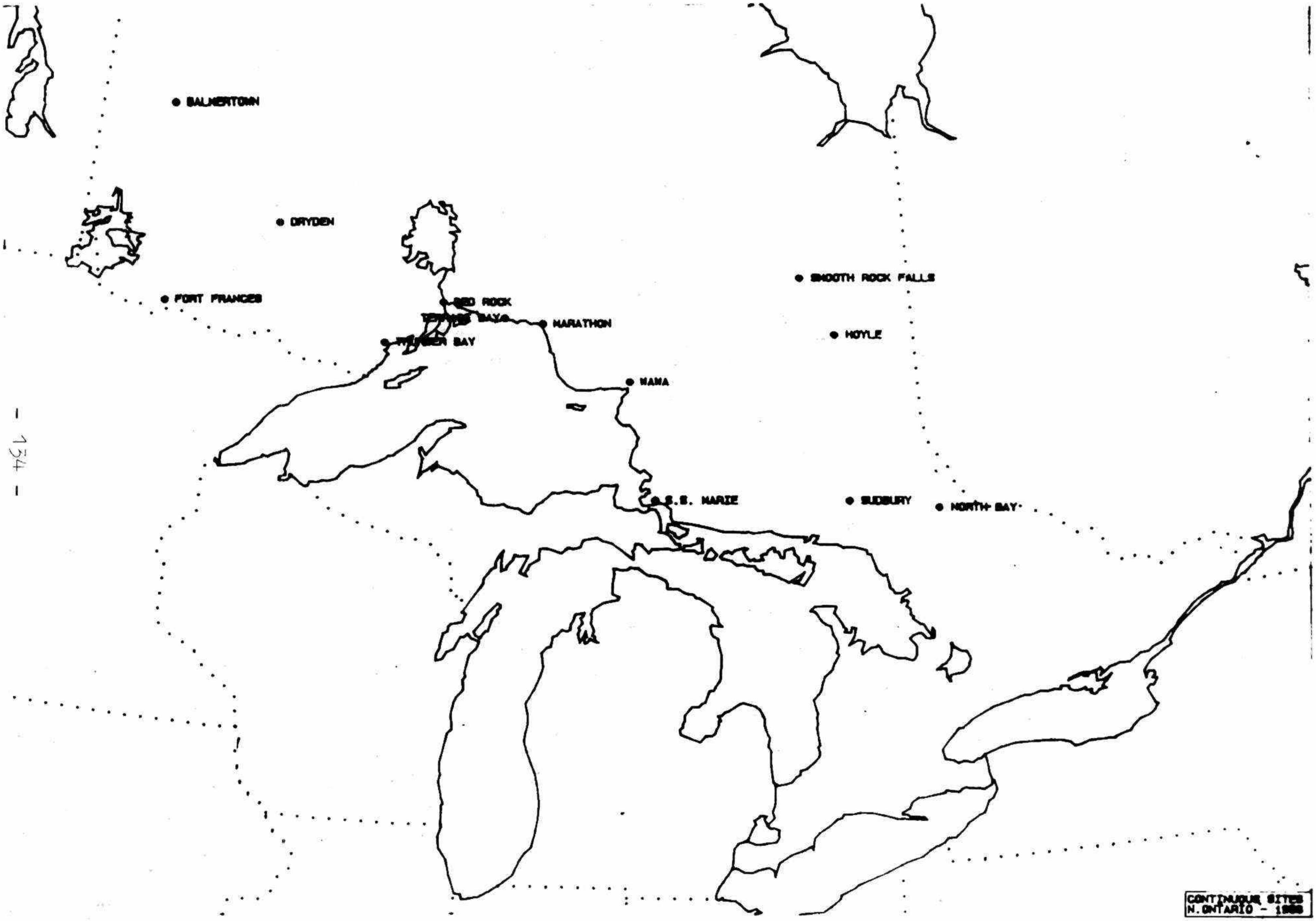

BALMERTOWN
DRYDEN
FORT FRANCES
RED ROCK
TERRACE BAY
THUNDER BAY
MARATHON
WAWA
SMOOTH ROCK FALLS
HOYLE
S.S. MARIE
SUDBURY
NORTH BAY
CONTINUOUS SITES
N.ONTARIO - 19[illegible]

Figure 2

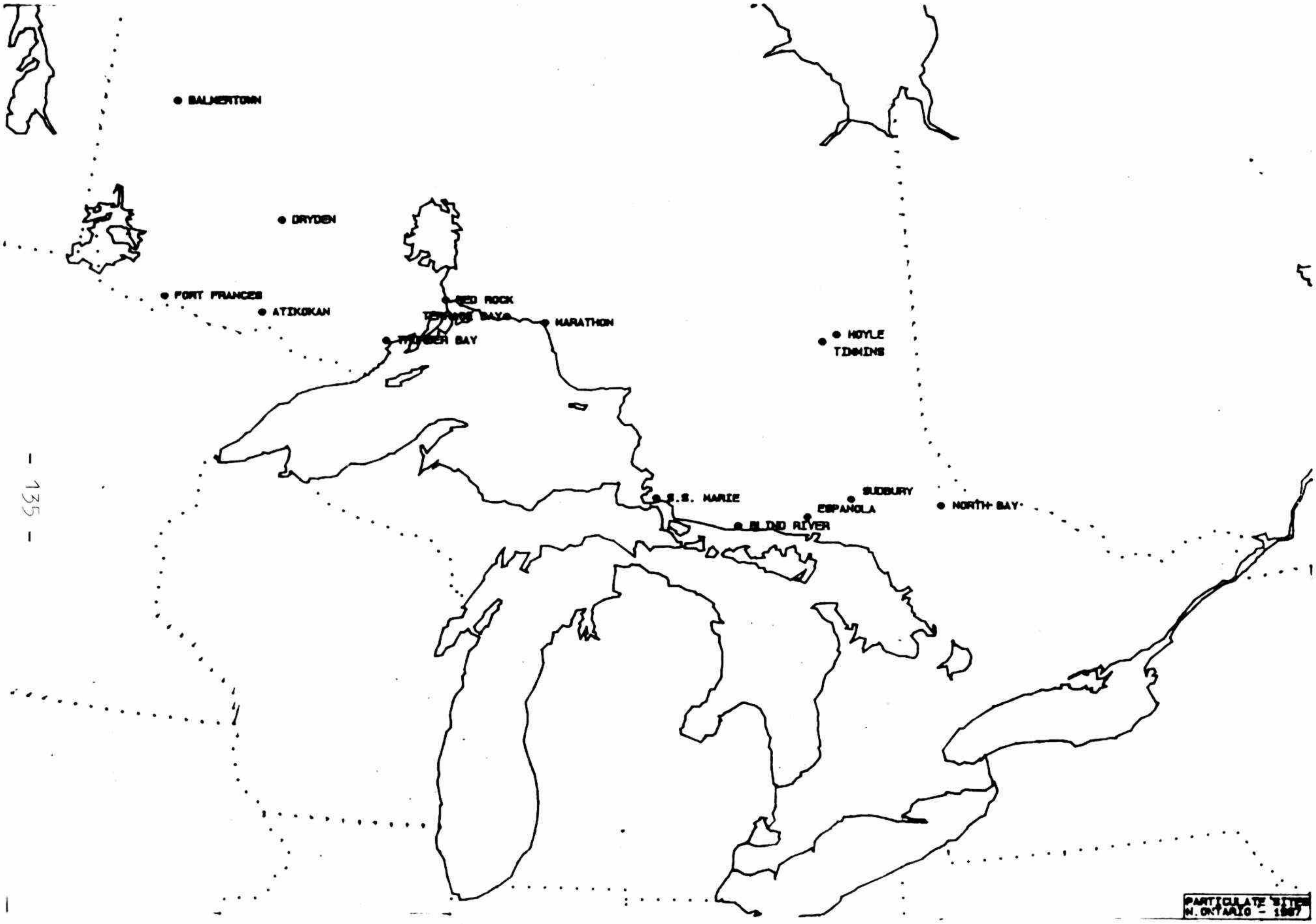

BALMERTOWN
DRYDEN
FORT FRANCES
ATIKOKAN
RED ROCK
TERRACE BAY
MARATHON
THUNDER BAY
HOYLE
TIMMINS
S.S. MARIE
SUDBURY
ESPANOLA
NORTH BAY
BLIND RIVER
PARTICULATE SITES
N.ONTARIO - 1987

Figure 3

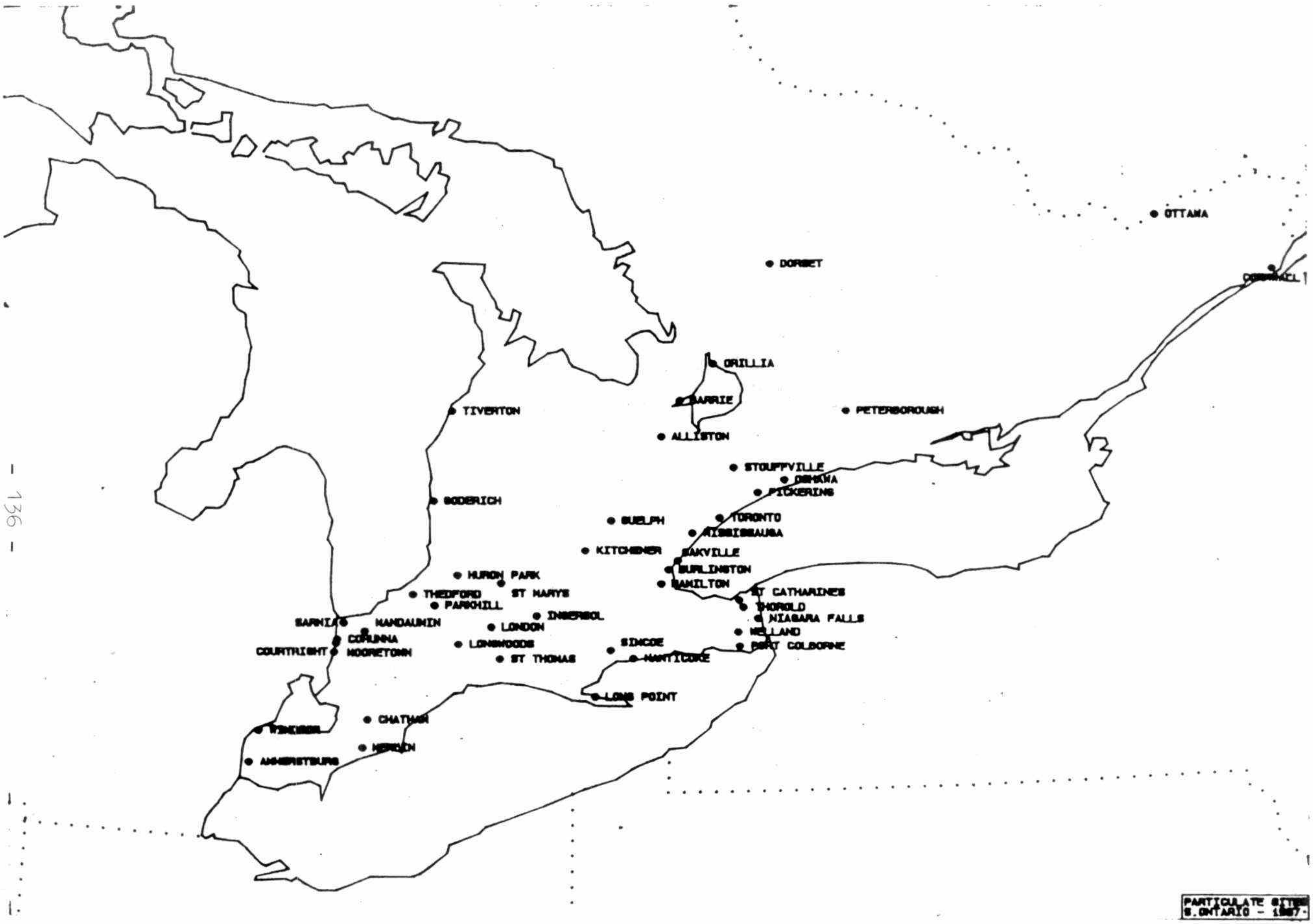

OTTAWA
DORSET
CORNWALL
ORILLIA
BARRIE
PETERBOROUGH
TIVERTON
ALLISTON
STOUFFVILLE
OSHAWA
PICKERING
GODERICH
GUELPH
TORONTO
MISSISSAUGA
KITCHENER
OAKVILLE
BURLINGTON
HURON PARK
ST MARYS
HAMILTON
ST CATHARINES
THEDFORD
PARKHILL
THOROLD
INGERSOL
NIAGARA FALLS
SARNIA
MANDAUMIN
LONDON
WELLAND
CORUNNA
LONGWOODS
SIMCOE
PORT COLBORNE
COURTRIGHT
MOORETOWN
ST THOMAS
NANTICOKE
LONG POINT
CHATHAM
WINDSOR
MERLIN
AMHERSTBURG
PARTICULATE SITES
S.ONTARIO - 1987

Figure 4

MINISTRY of the ENVIRONMENT

AIR MONITORING INSTRUMENTATION

POLLUTANT	INSTRUMENT MODEL	MEASURING RANGE (ppm)	DETECTION METHOD	AUDIT METHOD
SO2	ML 8850, TECO 43/43A, DASIBI 4108	0-0.5, 0-1.0, 0-2.0	U.V. Fluorescence Emission Spectroscopy	Permeation Tube
TRS (H_2S, CS_2, CH_3SH, etc)	ML 8780 (STI)	0-0.25, 0-0.5	Thermal Oxidation/U.V. Fluorescence Emission Spectroscopy	Permeation Tube
NO/NO_2	TECO 14, ML 8840	0-0.5, 0-1.0	Chemiluminescence Emission Spectroscopy/ NO_2 Reduced to NO	Gas Cylinder Dilution/ Gas Phase Titration
O_3	ML 8810, TECO 49, DASIBI 1003/1008, BENDIX 8003	0-0.5, 0-1.0	U.V. Absorption Photometry, Chemiluminescence Emission Spectroscopy	O_3 Generation by U.V.
CO	TECO 48, DASIBI 3008, Bendix 8501	0-50.0	Gas Filter Correlation Spectroscopy, Nondispersive Infrared Detection (NDIR)	Cylinder Gas
Hydrocarbons, Total/Reactive	Beckman 108/400 Bendix 8201	0-10.0 Methane 0-20.0 Total/Reactive	Flame Ionization Detection, GC-FID	Cylinder Gas
Particulates	General Metal Works		HiVol Filters/Gravimetric followed by Lab Analysis	Flow Orifice

Table 2

POLLUTANTS AND THEIR IMPACT

INDEX	CATEGORY	CARBON MONOXIDE CO	NITROGEN DIOXIDE NO2	OZONE O3	SULPHUR DIOXIDE SO2	SUSPENDED PARTICLES COH	API SO2+COH	TOTAL REDUCED SULPHUR TRS
100-150	VERY POOR	INCREASING CARDIOVASCULAR SYMPTOMS ON NON-SMOKERS WITH HEART DISEASE. SOME VISUAL IMPAIRMENT	INCREASING SENSITIVITY OF PATIENTS WITH ASTHMA AND BRONCHITIS	LIGHT EXERCISE PRODUCES EFFECT ON PATIENTS WITH CHRONIC PULMONARY DISEASE	INCREASING SENSITIVITY ON PATIENTS WITH ASTHMA AND BRONCHITIS	INCREASING SENSITIVITY ON PATIENTS WITH ASTHMA AND BRONCHITIS	SIGNIFICANT EFFECTS ON PATIENTS WITH ASTHMA AND BRONCHITIS	SENSITIVE INDIVIDUALS MAY SUFFER NAUSEA AND HEADACHES DUE TO SEVERE ODOUR
50-99	POOR	INCREASED CARDIOVASCULAR SYMPTOMS ON SMOKERS WITH HEART DISEASE	ODOUR AND DISCOLORATION. SOME INCREASE IN BRONCHIAL REACTIVITY IN ASTHMATICS	DECREASING PERFORMANCE BY ATHLETES EXERCISING HEAVILY	ODOUROUS. INCREASING VEGETATION DAMAGE AND SENSITIVITY	VISIBILITY DECREASED. SOILING EVIDENT	INCREASED SYMPTOMS TO PATIENTS WITH CHRONIC RESPIRATORY DISEASE	EXTREMELY ODOUROUS
32-49	MODERATE	NO DETECTABLE IMPAIRMENT	ODOUROUS	INJURIOUS TO MANY VEGETATION SPECIES E.G. WHITE BEANS, TOMATOES, ETC.	INJURIOUS TO SOME SPECIES OF VEGETATION	SOME DECREASE IN VISIBILITY	INJURIOUS TO VEGETATION DUE TO SULPHUR DIOXIDE	ODOUROUS
16-31	GOOD	NO EFFECTS	SLIGHT ODOUR	INJURIOUS TO SOME VEGETATION SPECIES IN COMBINATION WITH SO2 (4 HRS)	INJURIOUS TO SOME VEGETATION SPECIES IN COMBINATION WITH OZONE (4 HRS)	NO EFFECTS	NO EFFECTS	SLIGHT ODOURS
0-15	VERY GOOD	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS

Table 3

*DISTRIBUTION OF THE AQI (NUMBER OF HOURS) FOR JUNE 1988 - MAY 1989

	MODERATE	POOR	MAJOR POLLUTANTS
TORONTO - DOWNTOWN	110	6	O_3
TORONTO - WEST	134	8	O_3,SP
EAST YORK	60	0	O_3,SP
SCARBOROUGH	106	5	O_3,
NORTH YORK - CENTRAL	147	14	O_3,
NORTH YORK - WEST	97	1	O_3,SP
ETOBICOKE - NORTH	225	7	O_3,SP
ETOBICOKE - SOUTH	129	4	O_3,SP
YORK	212	12	O_3,SP

	MODERATE	POOR	MAJOR POLLUTANTS
BURLINGTON	70	3	O_3,SP
OAKVILLE	134	10	O_3,SP
OSHAWA	135	6	O_3,SP
MISSISSAUGA	127	6	O_3,SP
OTTAWA	66	4	O_3,SP
KINGSTON	84	6	O_3
CORNWALL	245	61	O_3,TRS
THUNDER BAY	0	0	-

*preliminary statistics

Table 4

*DISTRIBUTION OF THE AQI (NUMBER OF HOURS)
FOR JUNE 1988 - MAY 1989

	MODERATE	POOR	MAJOR POLLUTANTS
WINDSOR - UNIVERSITY	227	19	O_3,SP
WINDSOR - COLLEGE	319	21	O_3,TRS,SP
SARNIA	107	2	O_3
LONDON	156	7	O_3
KITCHENER	150	0	O_3
WATERLOO	63	1	O_3
NIAGARA FALLS	197	12	O_3
ST. CATHARINES	108	7	O_3
GUELPH	107	0	O_3

	MODERATE	POOR	MAJOR POLLUTANTS
HAMILTON - DOWNTOWN	223	10	O_3,SP
HAMILTON - EAST	112	2	O_3,SP
HAMILTON - MOUNTAIN	155	5	O_3,TRS
HAMILTON - WEST	203	6	O_3,SP
SAULT STE MARIE	66	1	SP,TRS,O_3
NORTH BAY	128	0	O_3,SP
SUDBURY	88	13	O_3,SO_2

*preliminary statistics

Table 5

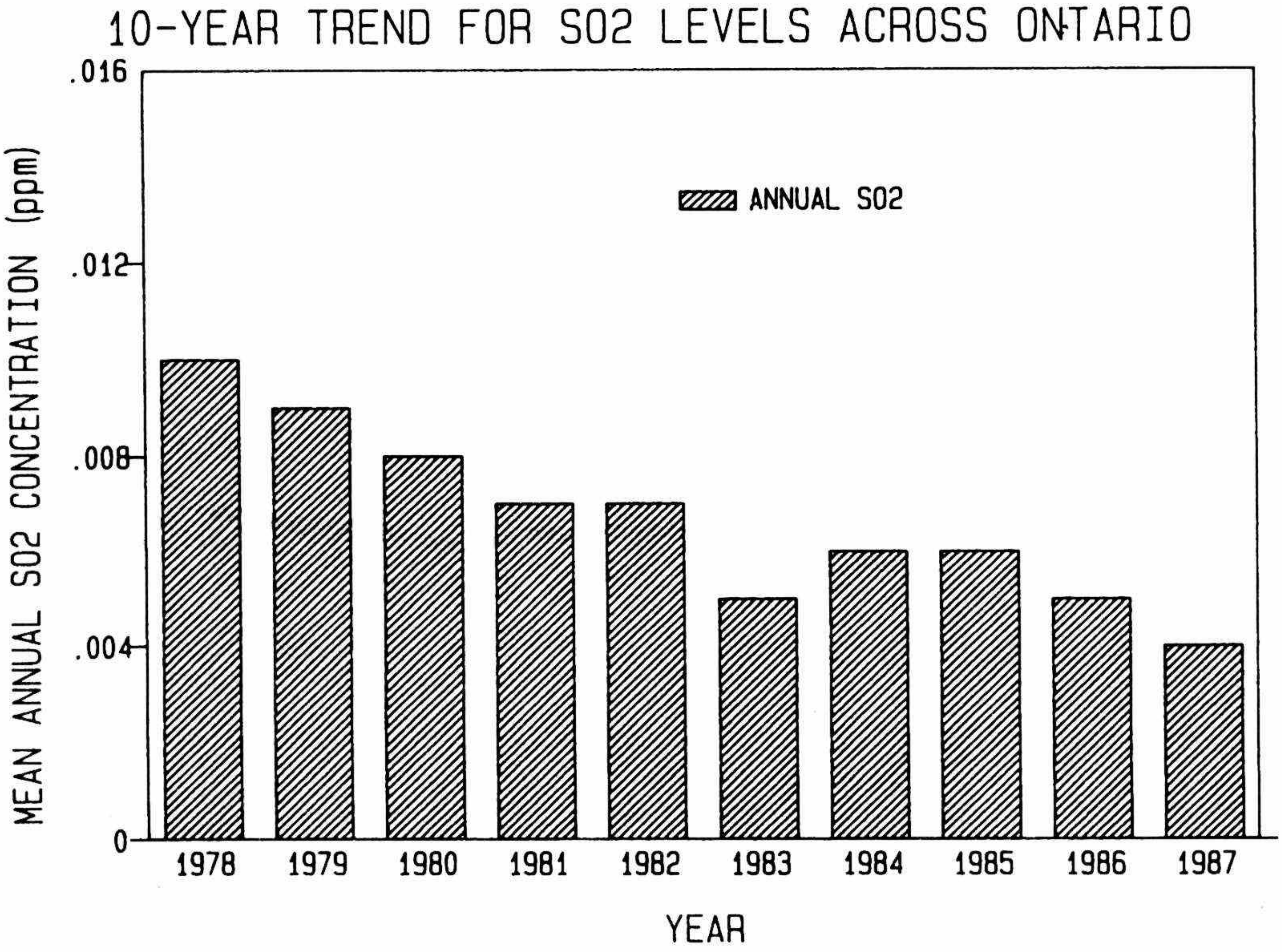


Figure 5 60% reduction

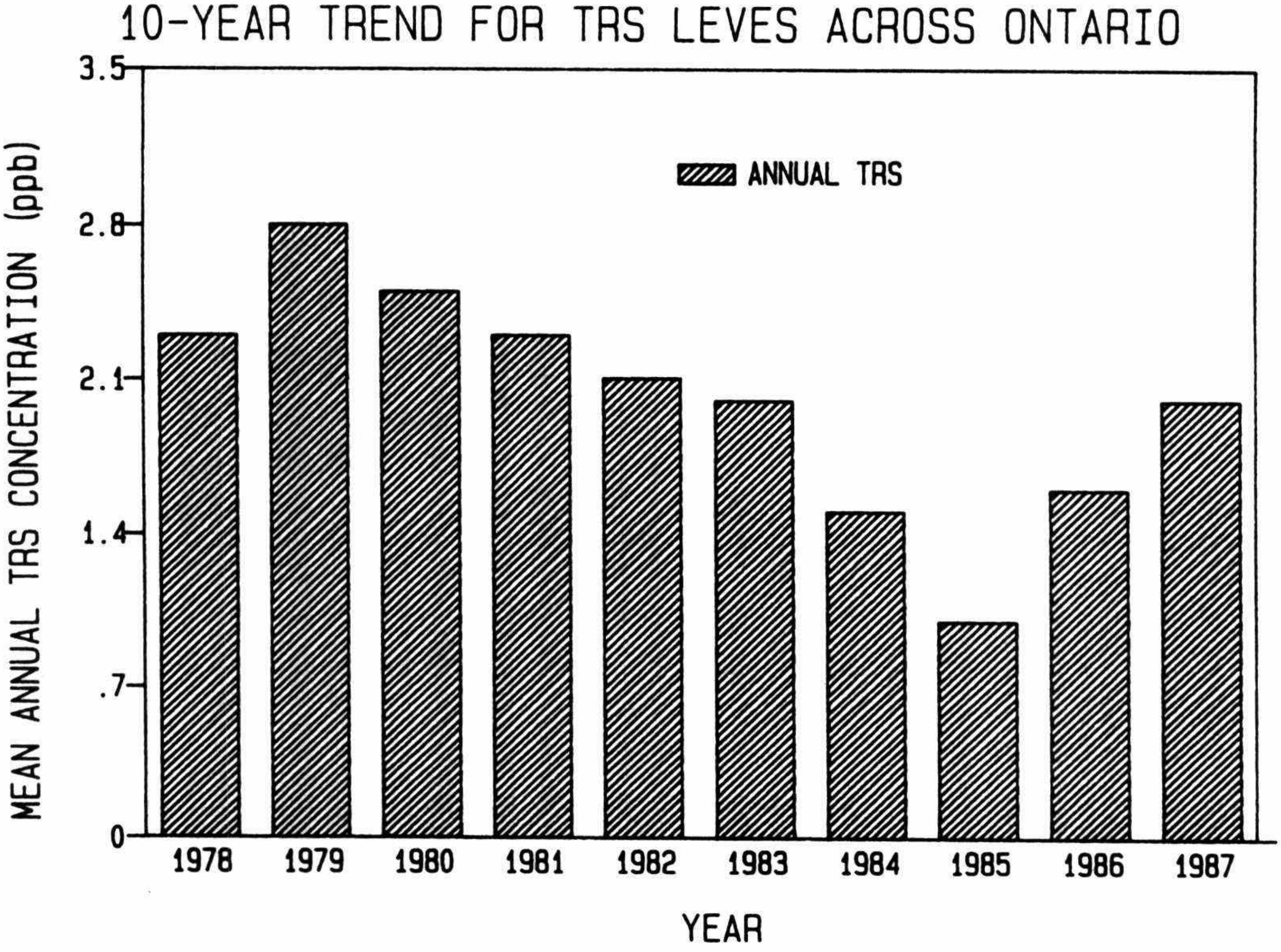

10-YEAR TREND FOR TRS LEVES ACROSS ONTARIO
MEAN ANNUAL TRS CONCENTRATION (ppb)
3.5
2.8
2.1
1.4
.7
0
▨ ANNUAL TRS
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
YEAR

Figure 6

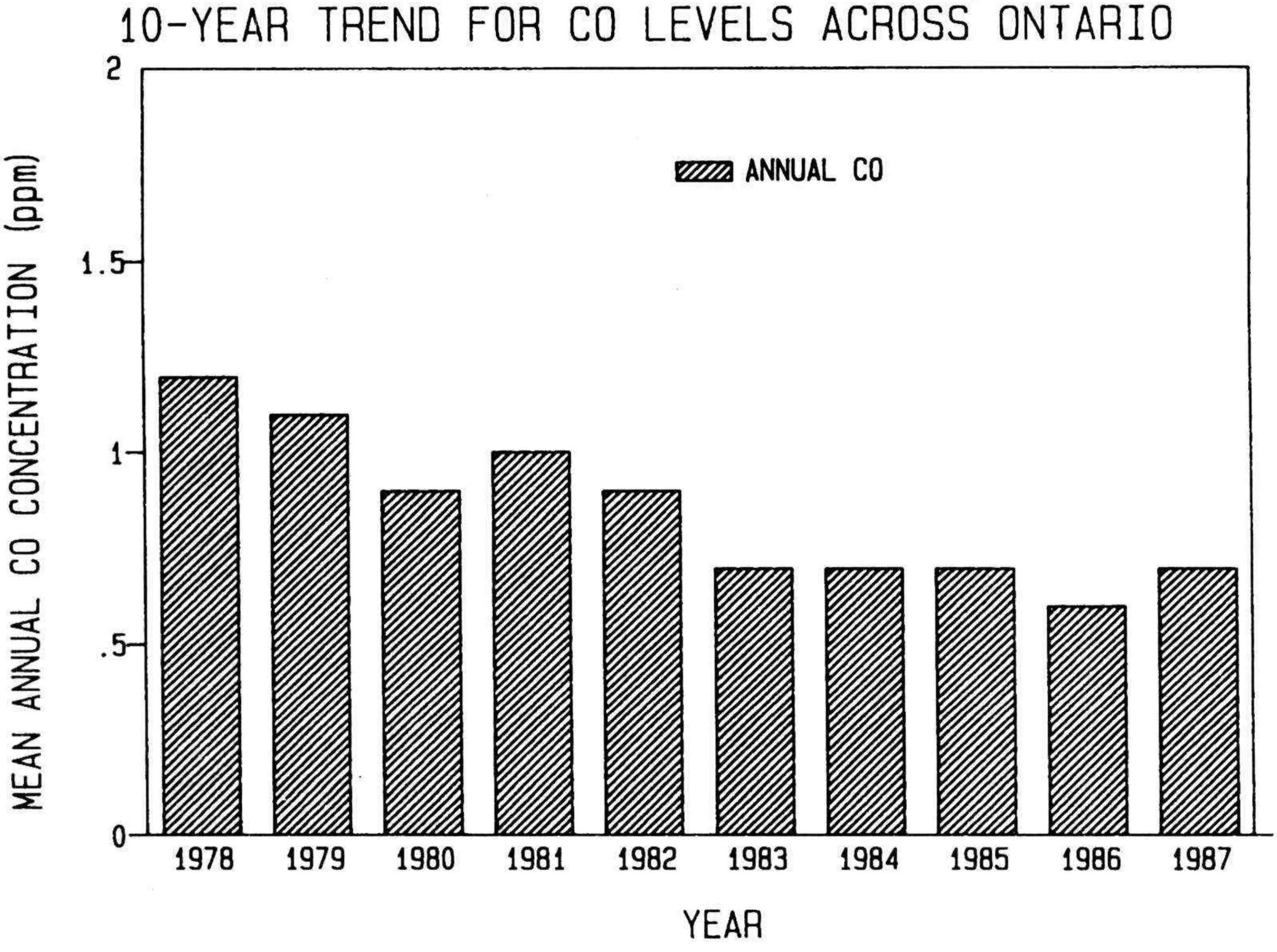

10-YEAR TREND FOR CO LEVELS ACROSS ONTARIO
▨ ANNUAL CO
MEAN ANNUAL CO CONCENTRATION (ppm)
2
1.5
1
.5
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
YEAR

Figure 7

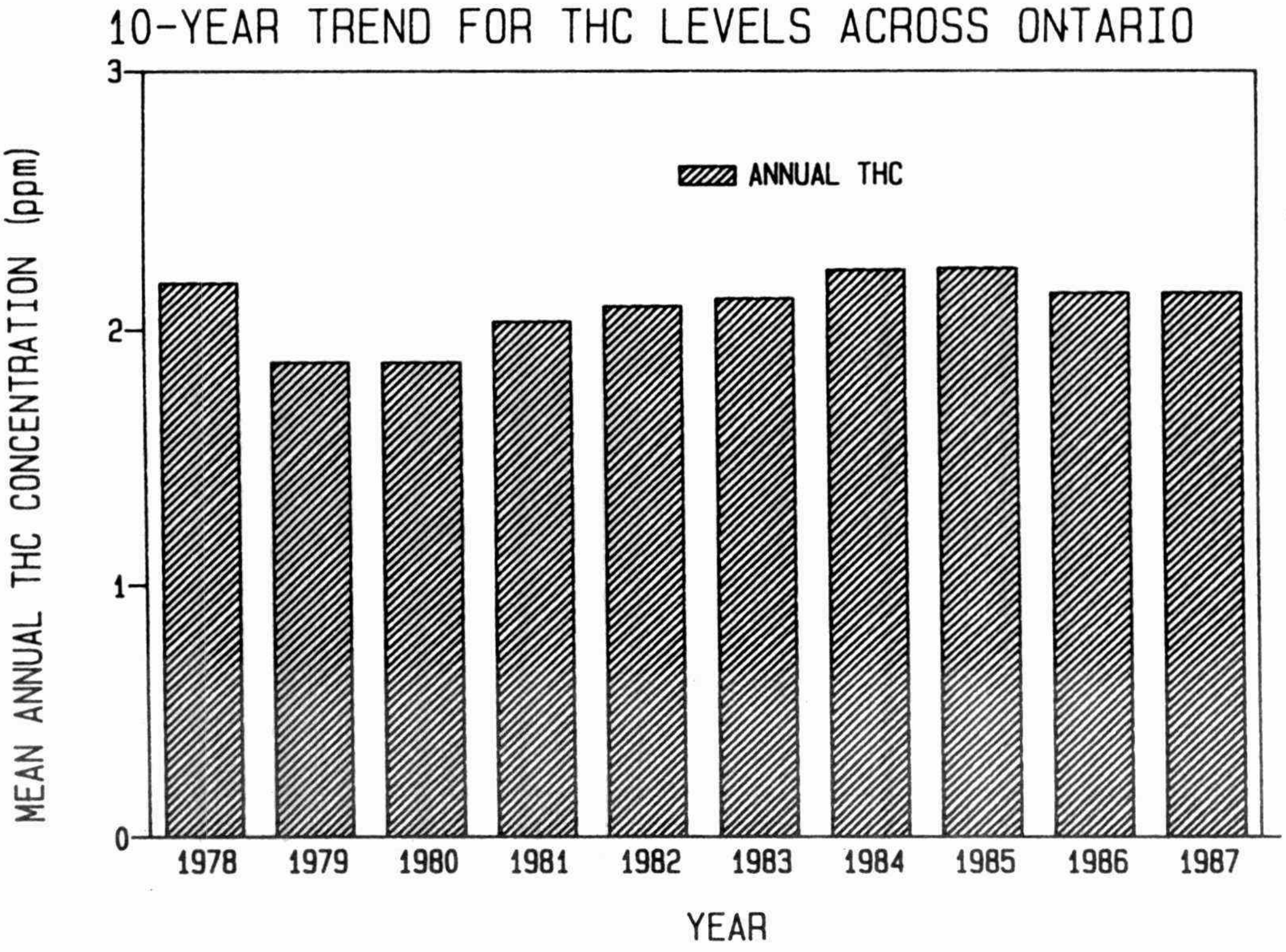


Figure 8

no clear trend

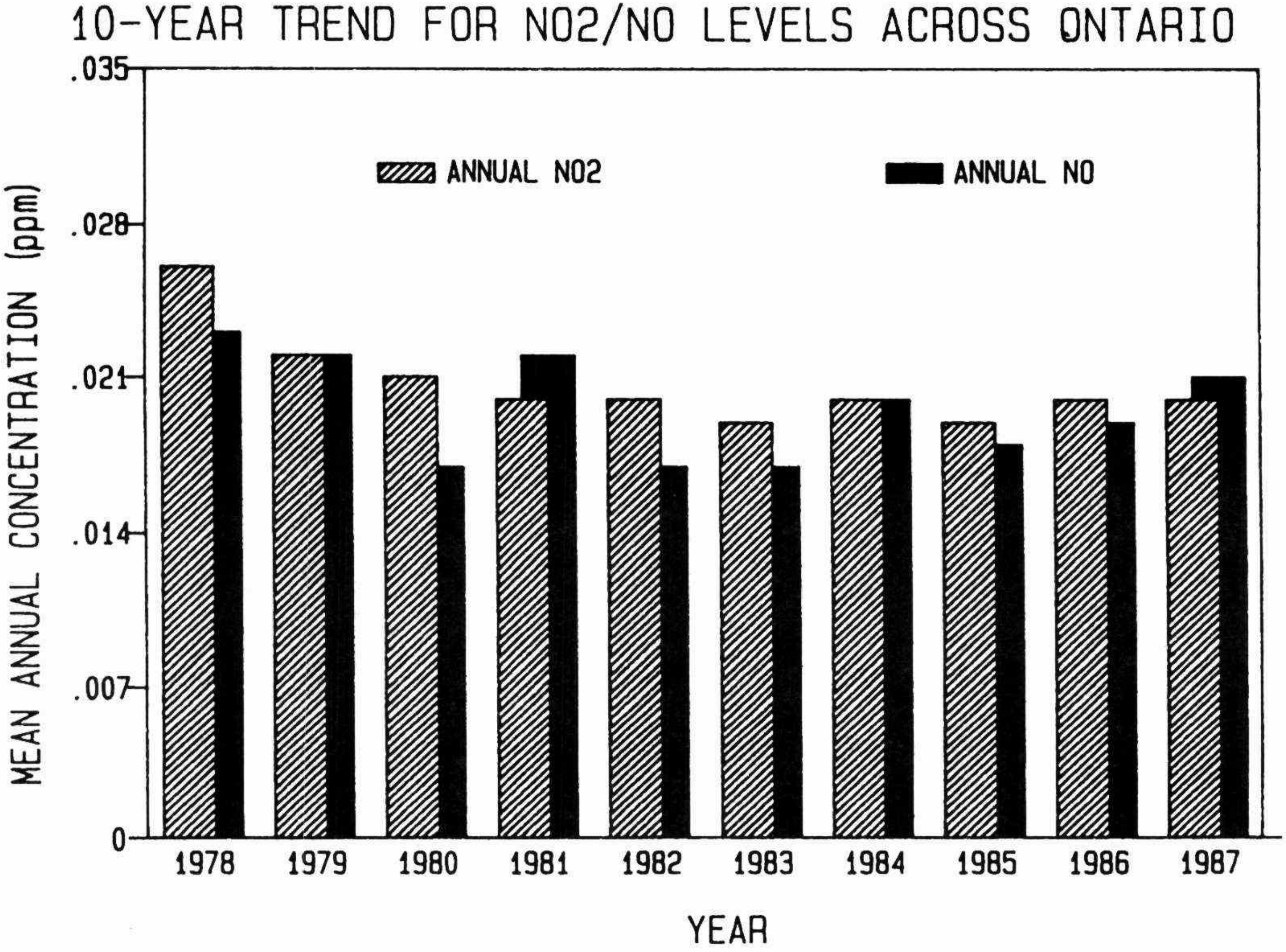


Figure 9

improved, tighten auto emission
control

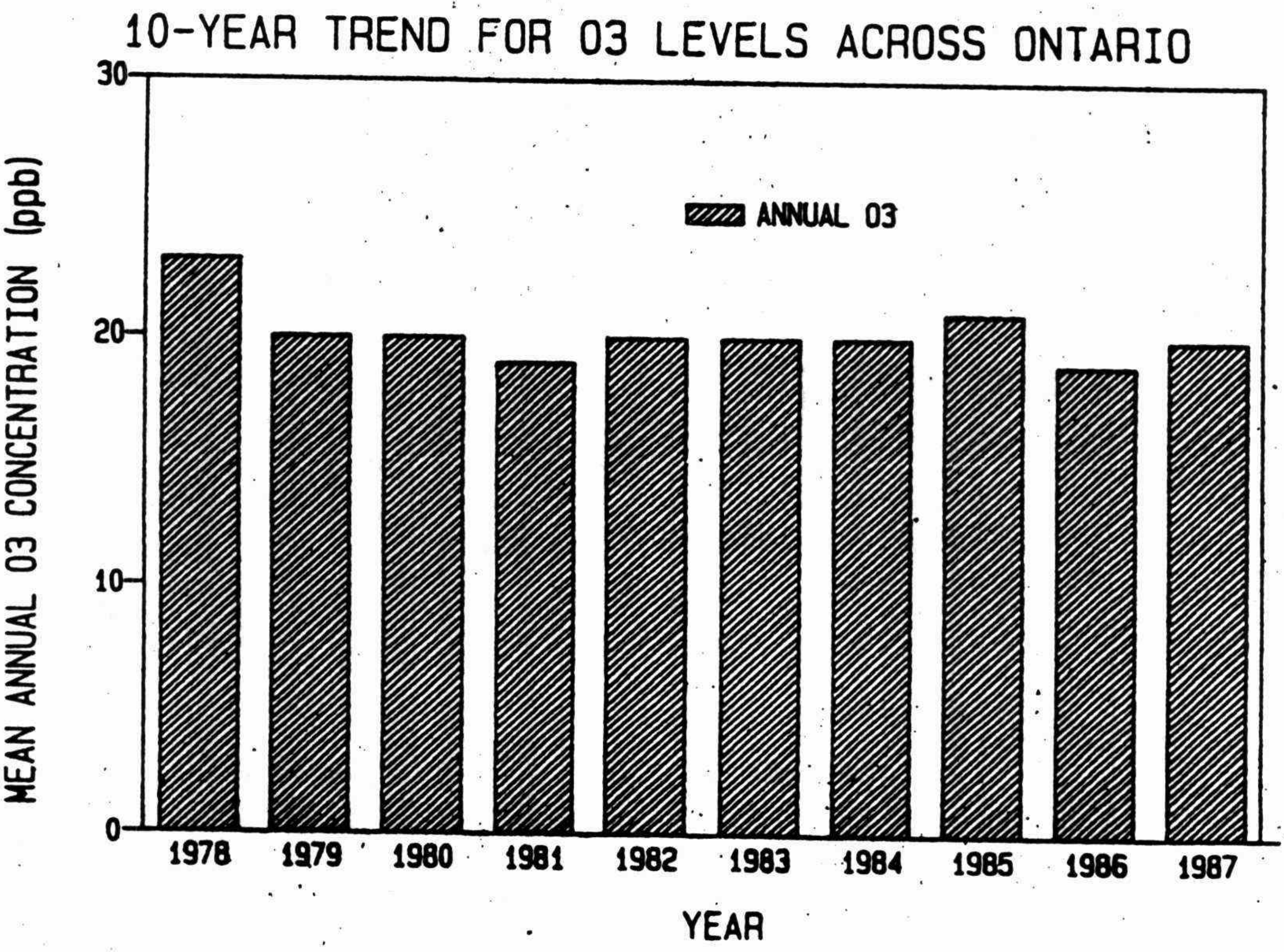

10-YEAR TREND FOR 03 LEVELS ACROSS ONTARIO
MEAN ANNUAL 03 CONCENTRATION (ppb)
30
20
10
0
ANNUAL 03
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
YEAR

Figure 10

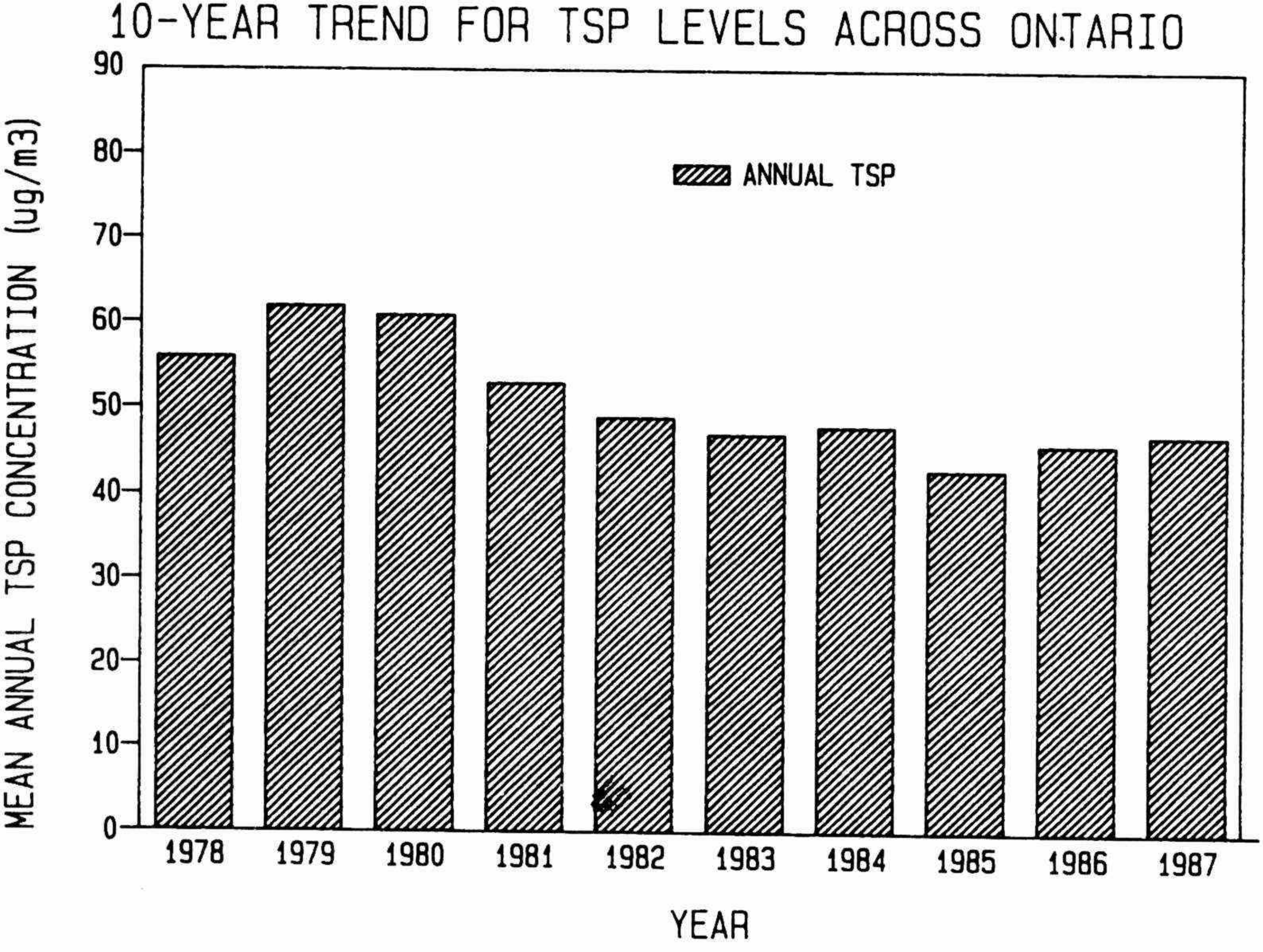

10-YEAR TREND FOR TSP LEVELS ACROSS ONTARIO
ANNUAL TSP
MEAN ANNUAL TSP CONCENTRATION (ug/m3)
90
80
70
60
50
40
30
20
10
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
YEAR

Figure 11

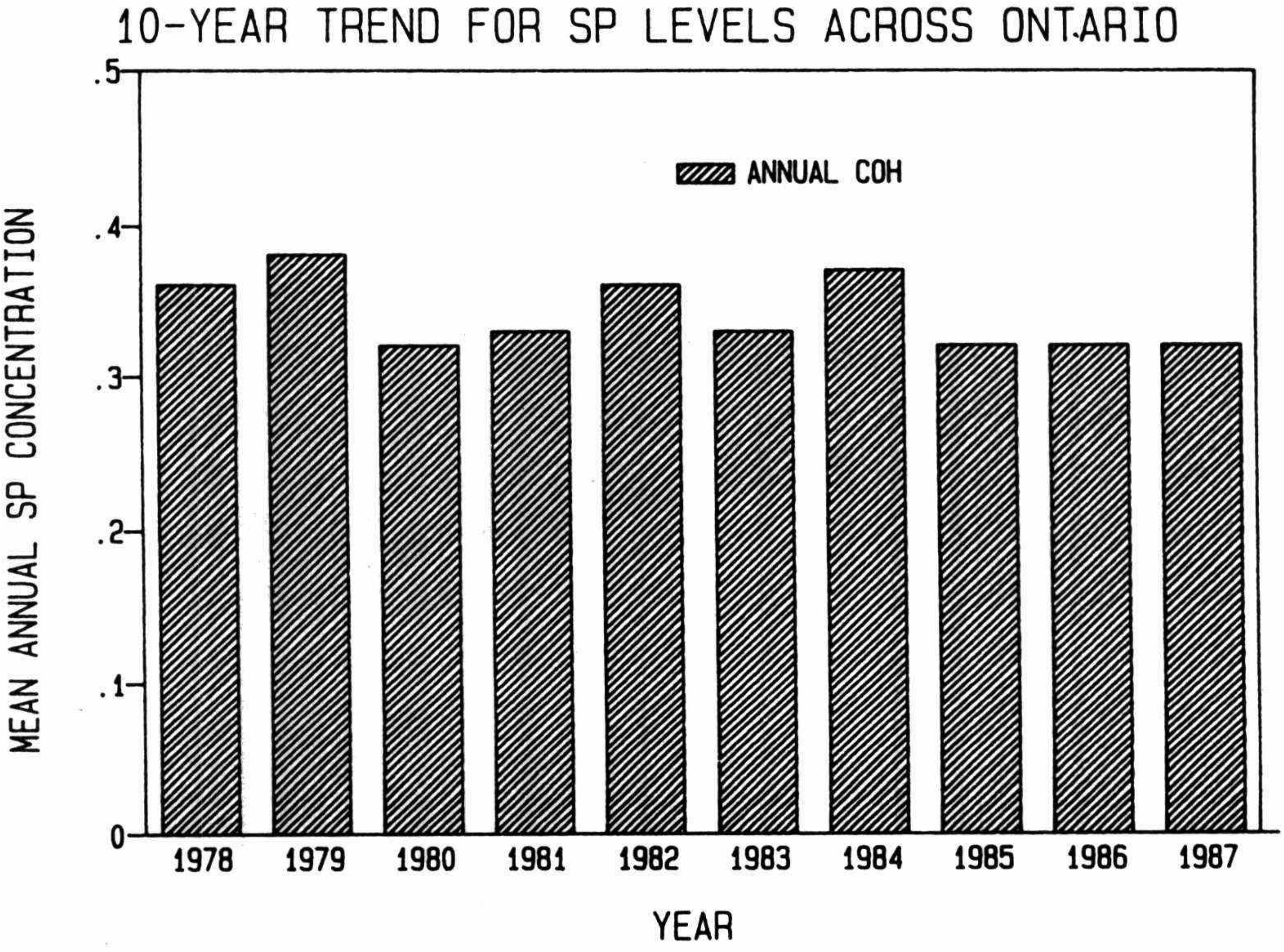


Figure 12

source:variety of industrial activities

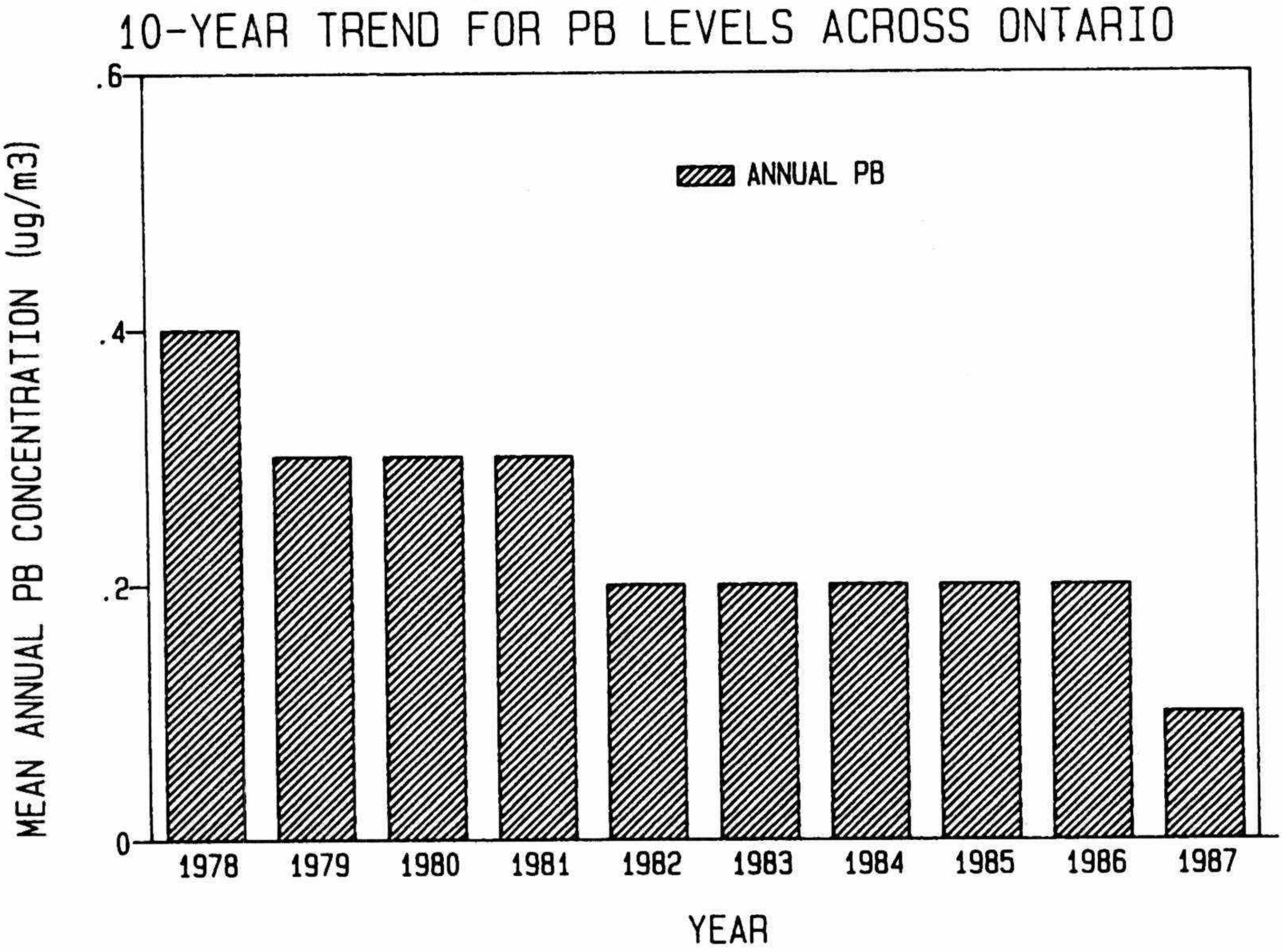
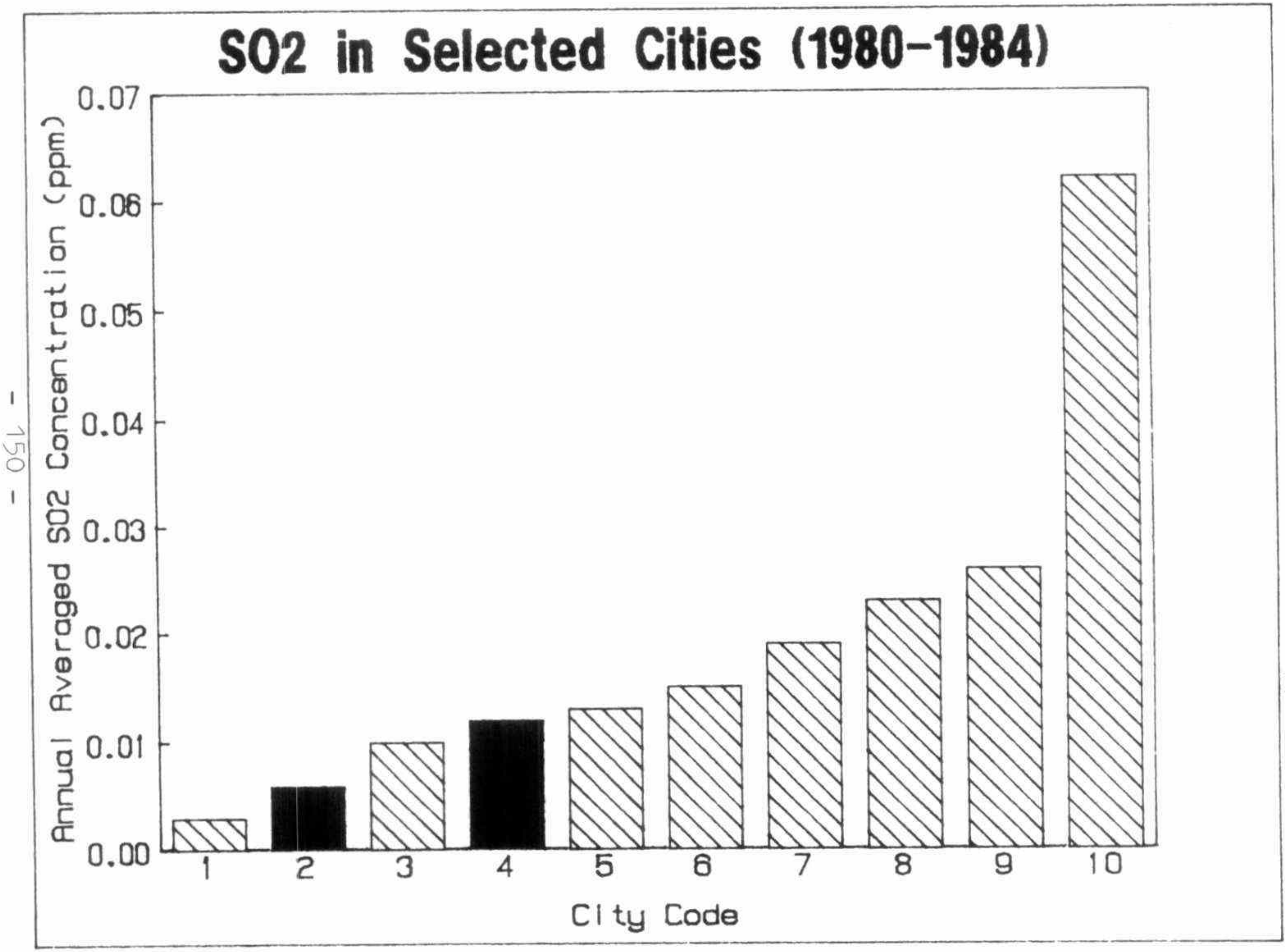

10-YEAR TREND FOR PB LEVELS ACROSS ONTARIO
▨ ANNUAL PB
MEAN ANNUAL PB CONCENTRATION (ug/m3)
.6
.4
.2
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
YEAR

Figure 13



1. Melbourne
2. Toronto
3. Helsinki
4. Hamilton
5. Tokyo
6. New Delhi
7. New York
8. Frankfurt
9. Paris
10. Milan

Figure 14

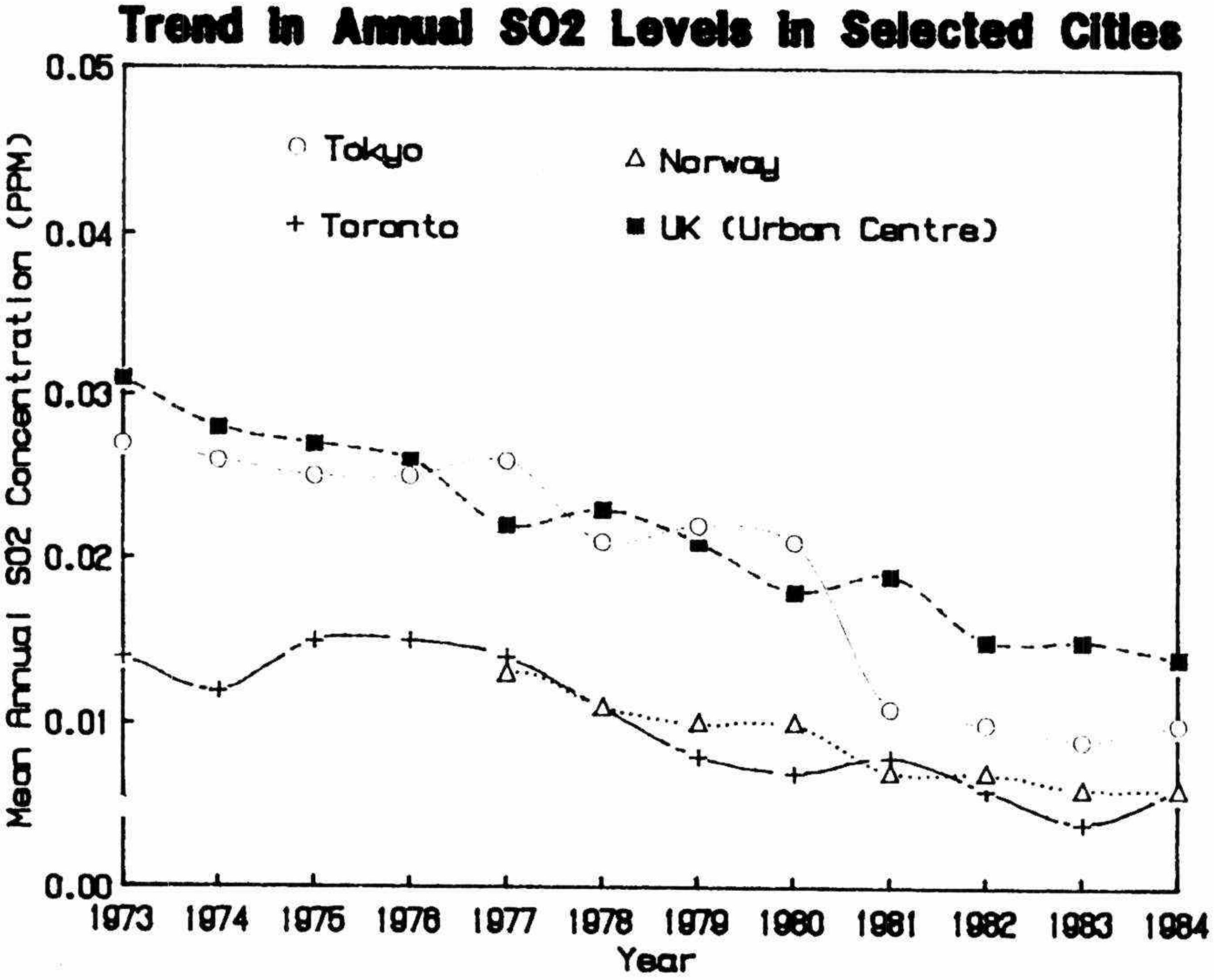
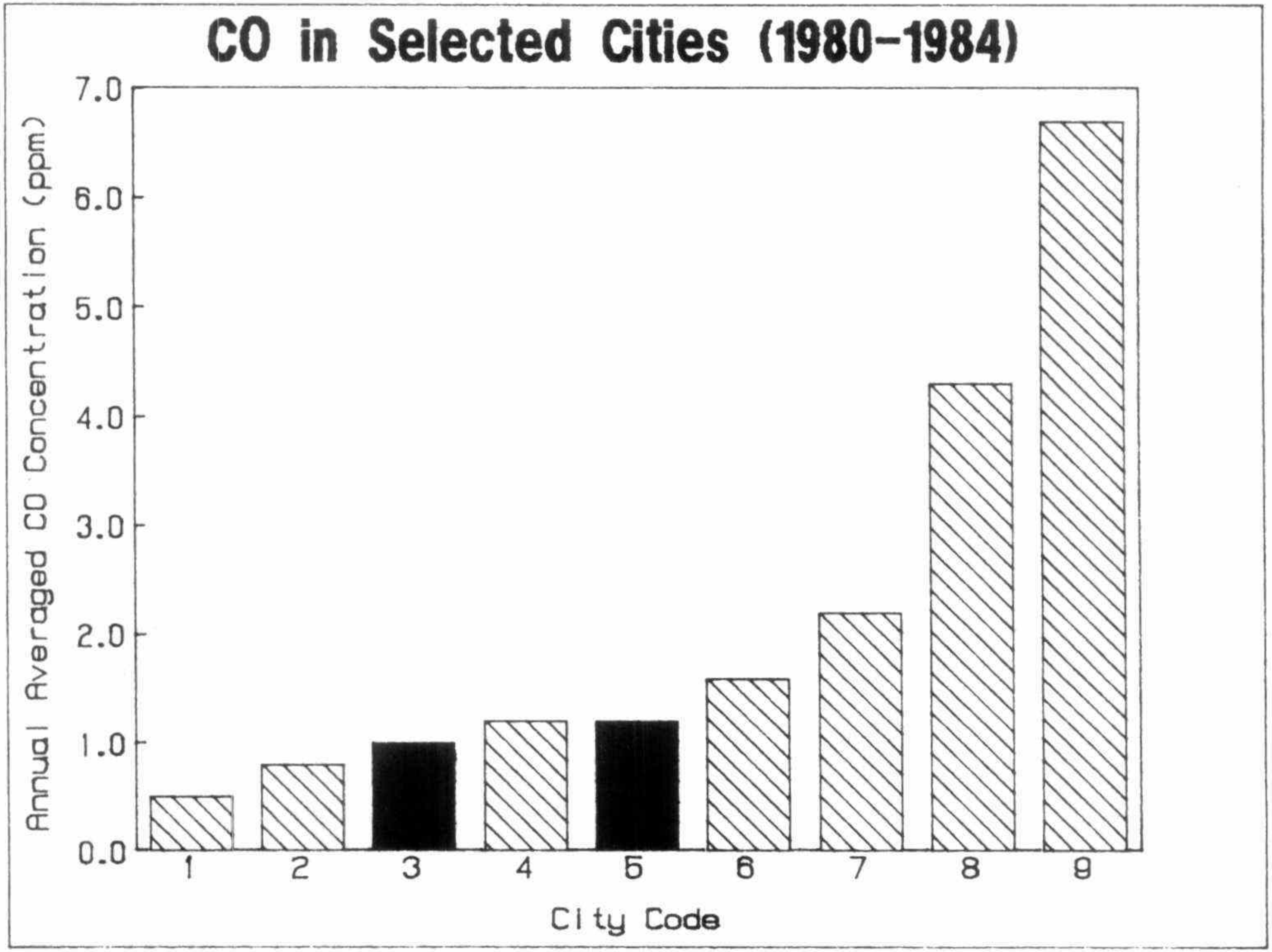
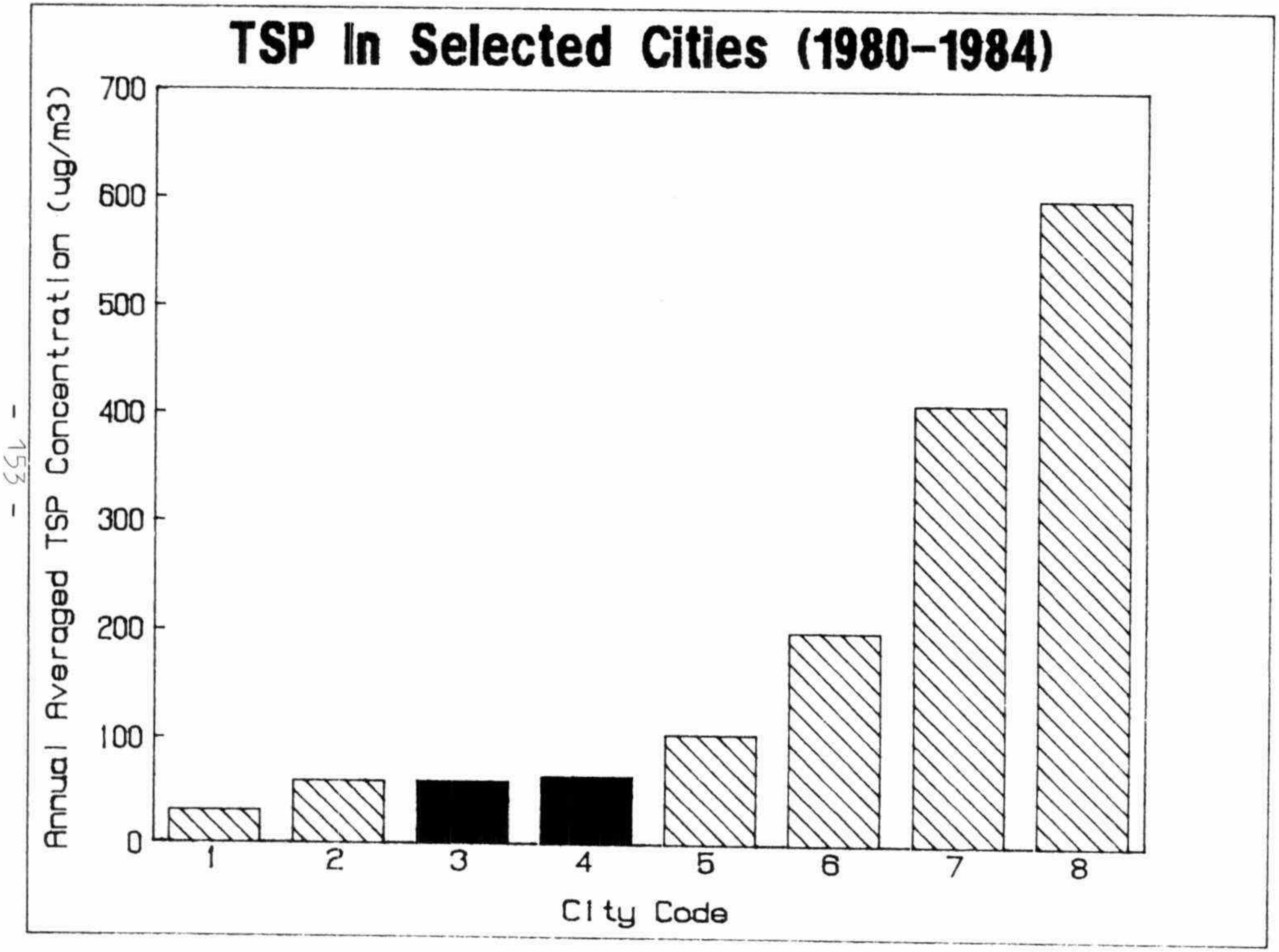

Trend in Annual SO2 Levels in Selected Cities
○ Tokyo
△ Norway
+ Toronto
■ UK (Urban Centre)
Mean Annual SO2 Concentration (PPM)
0.05
0.04
0.03
0.02
0.01
0.00
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
Year

Figure 15



1. Amsterdam
2. Tokyo
3. Hamilton
4. Zurich
5. Toronto
6. Frankfurt
7. Stockholm
8. Oslo
9. Paris

Figure 16



1. Frankfurt
2. Tokyo
3. Toronto
4. Hamilton
5. Lisbon
6. Bombay
7. New Delhi
8. Kuwait

Figure 17

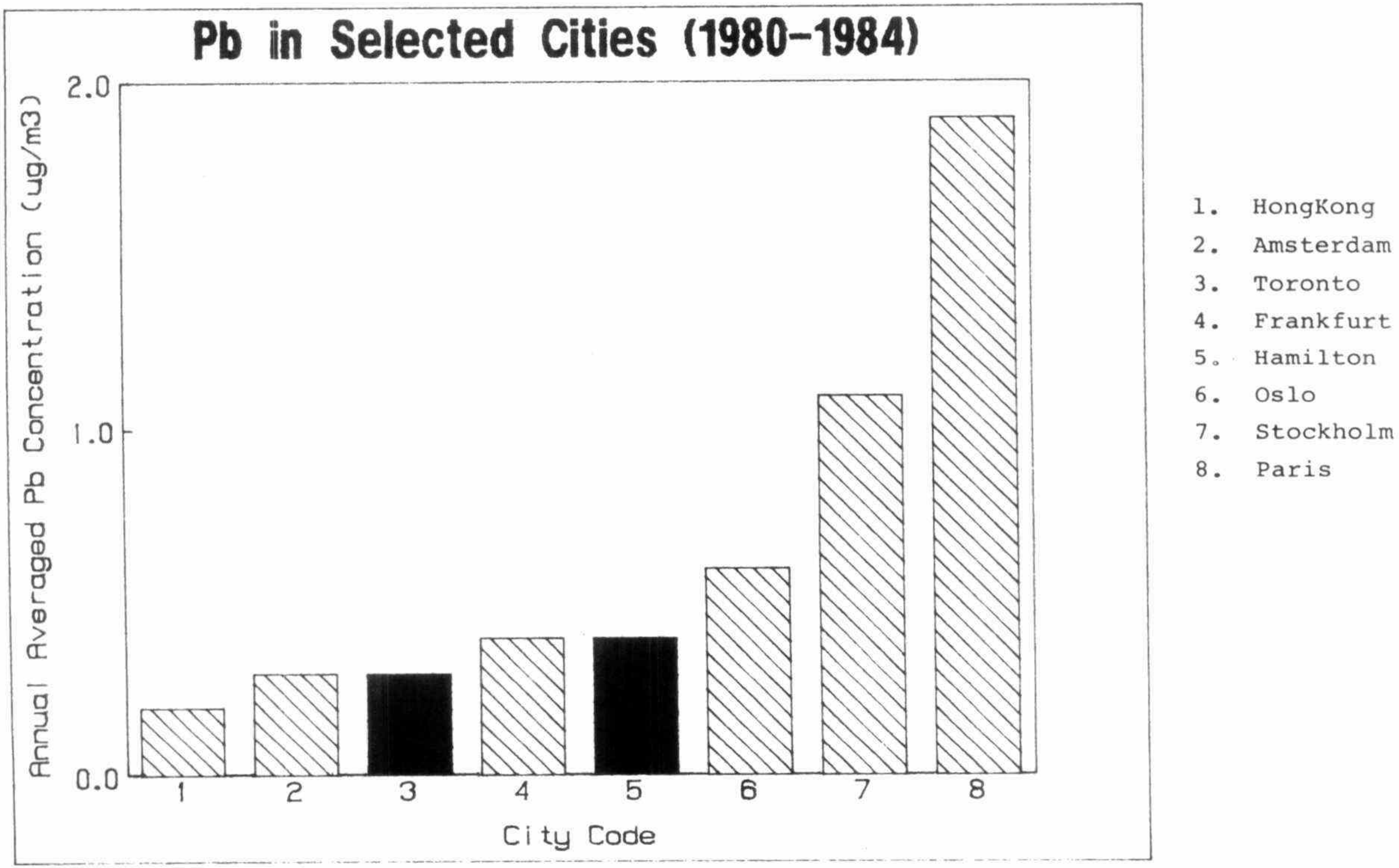
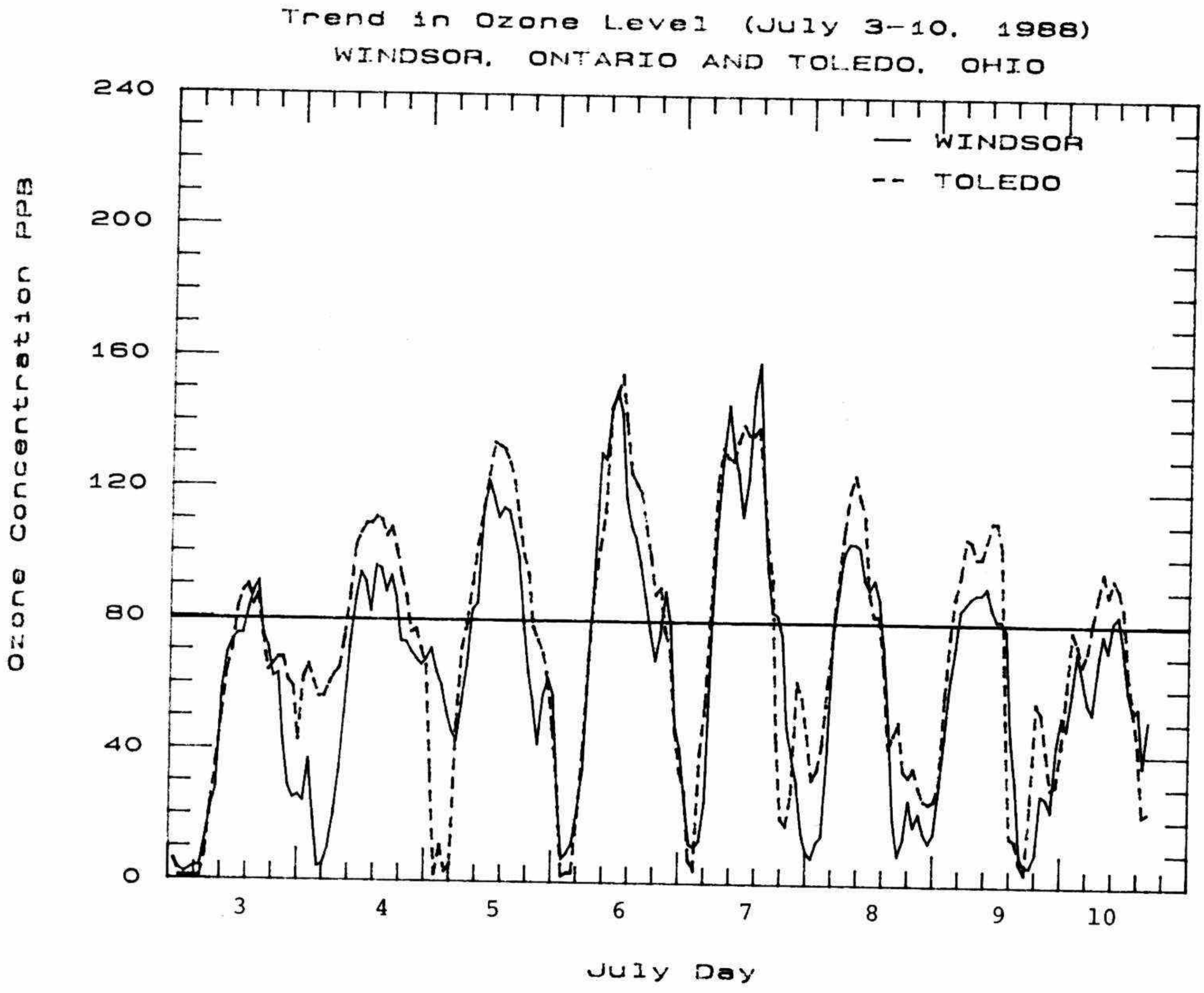

Pb in Selected Cities (1980-1984)
Annual Averaged Pb Concentration (ug/m3)
2.0
1.0
0.0
1
2
3
4
5
6
7
8
City Code
1. HongKong
2. Amsterdam
3. Toronto
4. Frankfurt
5. Hamilton
6. Oslo
7. Stockholm
8. Paris

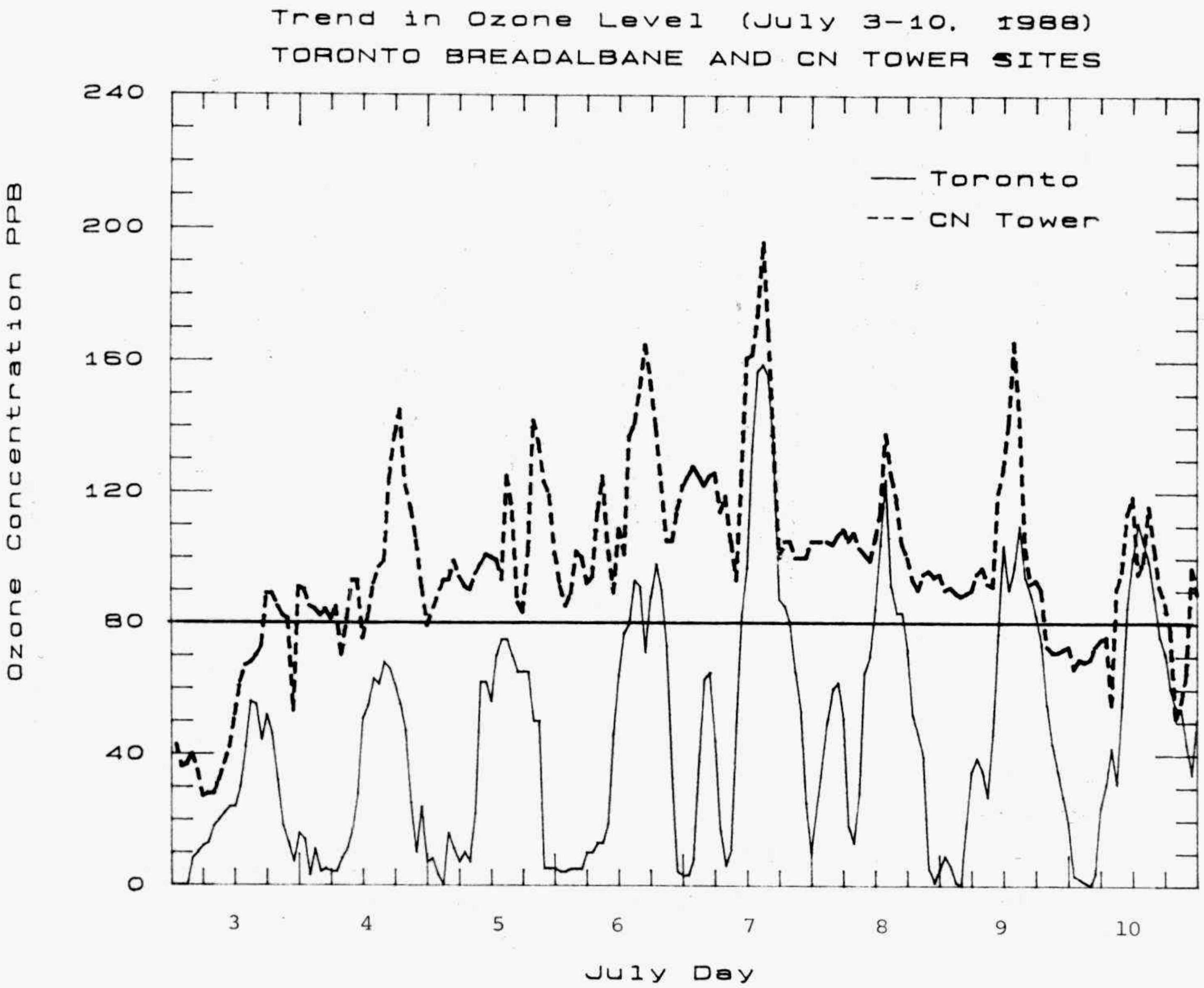
Figure 18



5 day episode
air mass changed
from SW to W

oxidation of SO2, NO2
sulphat and nitrate
high on 7,8

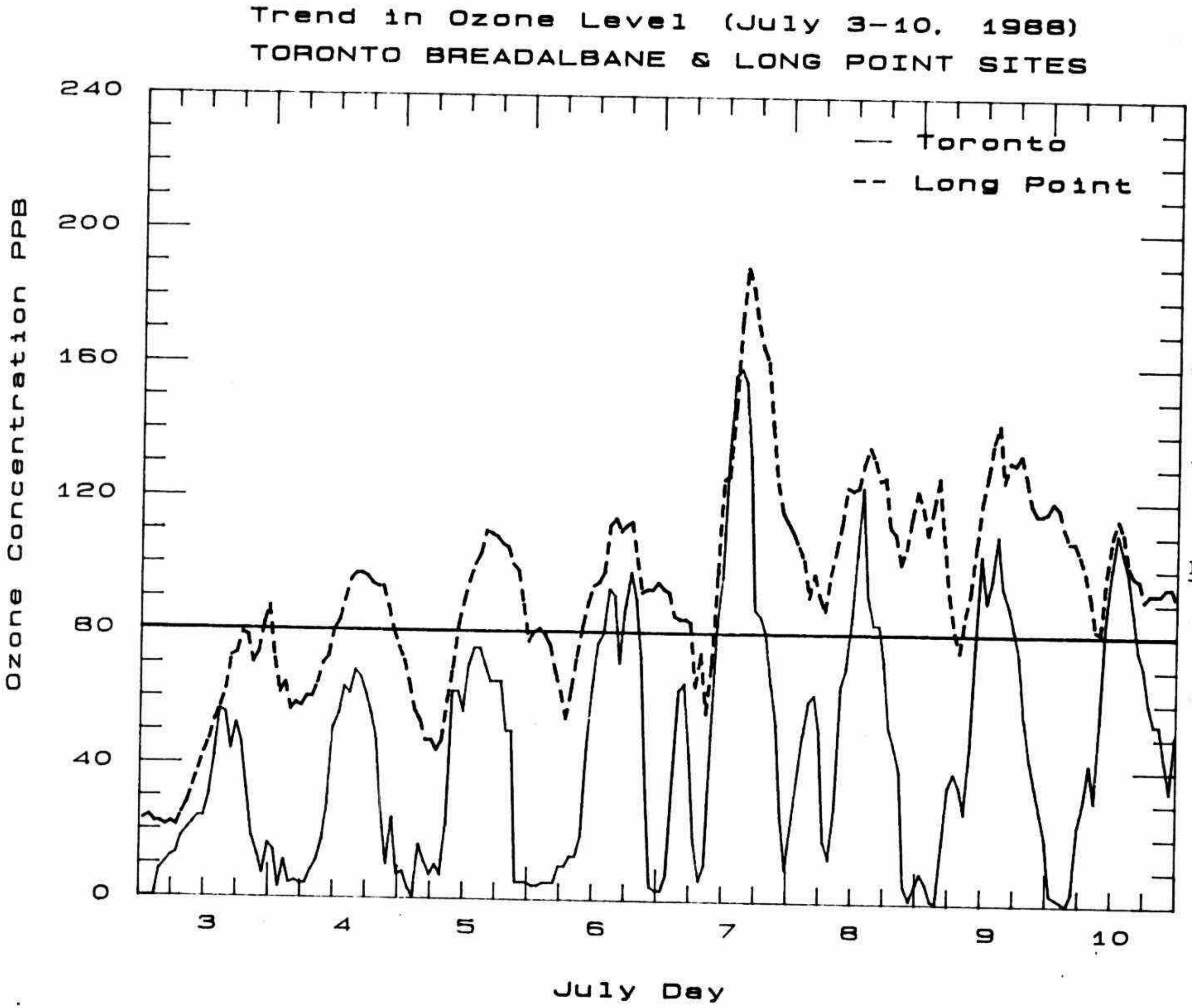
Figure 19



CN TOWER

- 440m
- less variation
- higher than Long Point and Toronto
- Ozone River aloft
- from ground nocturnal inversion

Figure 20



- Diurnal effect: Max Midday
  Min. Morning

-Photochemical reaction reverse at night

Lower value at Toronto

(i) further away from U.S. source region

(ii) scavanging of O3 by NO in city

Figure 21

THE ROLE OF THE ODOUR IMPACT MODEL IN STANDARD SETTING IN ONTARIO

by

G. Nagy, Coordinator Standards Setting,
Air Resources Branch, Environment Ontario

1. The ARB has the mandate to develop and set ambient air standards in Ontario for pollutants like SO2. CO. O3. TRS. H2S - the well known gas with the rotten egg odour. At the present we have set standards. guidelines. provisional guidelines. etc.. for 312 chemical compounds.

2. What are odours? Things that don't smell good, in a subjective way. A bakery or a brewery smell good to me. but not to others. Sewage treatment plant odours most people would agree are disagreeable.

2.1 There is a great body of technical literature on odours: It is possible to study odours from the point of view of the response of the human nervous system to various kinds of stimulus. e.g. to the pleasant or unpleasant odours. or the influence of socio economic status, or the various ways of conducting community surveys to assess community opinion about odour.

3. The permanent thing about odour problems is that they generate complaints which find their way to the air pollution control agency of the jurisdiction. which here in Ontario is the MOE.

4. The MOE is then faced with the problem of odours. it must find an approach that will mitigate the problem in the long term and the short term. and deal with the subjective nature of this issue.

4.1 Setting an adequate standard and having it available in conjunction with the Certificate of Approval requirement of Section 8 of the Environmental Protection Act should in theory ensure that new industrial facilities will not create odour problems. So the long term problem is mitigated by having a good standard.

4.2 Odour problems in the short term are usually caused by plant upsets, mistakes in old designs, etc.. and in theory these too can be mitigated by forcing the polluter to redesign emission control systems to meet standards.

4.3 The arguments presented above would be airtight if there weren't mixtures with synergistic effects or large areas where odourous processes are concentrated. A good standard can help and in fact its the first step in the solution of ordinary odour problems. I will now deal with ordinary odour problems. i.e. those that do not involve difficult mixtures, and return to mixtures later.

5. In order to set standards for odouorous substances the ARB has developed the odour impact model which can be applied in the analysis of environmental odour problems.

5.1 To illustrate my point I would like to draw your attention to the slide which shows the odour impact model for Hydrogen Sulphide the well known gas with the rotten egg smell.

5.2 A great deal of assistance in developing this model was received from Dr.A. Gnyp of the University of Windsor.

5.3 The odour impact model is a graphical representation of the response of a sample of the human population (called the odour panel) to the stimulus of a specific odour, in this case the odour of H2S, under the controlled conditions of a scientific experiment.
In this experiment a minimum sample of 9 people (the more the better) are selected to participate in the odour panel. Increasing concentrations of the odourant are administered and panel members record their reaction in terms of detection, complaint, and annoyance. These reactions are graphed as functions of concentration and it is possible by looking at the graph to pick out a concentration acceptable for standard setting. For example if we wanted to set a standard for H2S, we could set it at 5.5 ug/m3 which is the 50% detection level. We would of course check the health effect and have health experts satisfy themselves that any health effects occur at higher concentrations.
An additional aspect of the standard setting process is the decision about the percentage of the population that will be allowed to detect the odour and this is a difficult decision. The ARB's Environmental Air Standards Setting Committee has recommended that the standard be set at the 50% detection level for a period of 10 minutes. In other words for an odourous compound, the primary design standard will limit emissions to the point where ambient air concentrations of the odourant will be less than the 50% detection level as indicated on the odour impact model and will persist for no longer than 10 minutes. Persistence of the concentration beyond 10 minutes or exceedence of of the concentration would constitute an exceedence of the standard.

The most important feature of the model is that it shows that human response varies, in other words the concentration that may annoy or even torment some people will not be detected by others. And this is true in the case of virtually all odourous substances. We have contracted for the determination of over 90 odour impact models and they all have the familiar "S" shape.

5.3.3 It is obvious from the above that the Odour Impact Model will play an important role in the setting of odour based standards. Because of this importance the ARB has developed a procedure for the determination of odour impact models which is a public document which specifies in great detail how a laboratory shall go about the determination. You are welcome to pick up copies of this procedure right here or by calling the ARB for a copy.

6. At this point I would like to return to my earlier statement on the problems with mixtures, and present to you a possible approach using the odour impact model: In the real world we are confronted with mixtures of many compounds which assault our noses. This approach would collect the odourous sample from the source or the ambient air in a Tedlar bag, establish its odour impact model in the laboratory, set the standard (in terms of odour units), model emissions to predict ambient levels, compare the standard to the ambient level and present the results to the polluter if the modelled results exceed the standard - this is called developing an abatement strategy. Unfortunately this is not as simple as it sounds. There is a good possibility that the panel's reaction to the mixture will be very complex and the approach will not work. In fact at the present there is no accepted theory for analyzing the impact of mixtures, and the ARB would be very interested in learning about any new approaches. The simple additive model found in Reference 2 has not found general acceptance.

6. Summary

6.1 The first step in the resolution of an odour problem is to determine that one exists, as evidenced by serious (not spurious) complaints, that are adequately documented.

6.2 Establish the identity of the source and identify the specific chemical compound causing the odour, (assuming of course that this is a simple case where there are no mixtures).

6.3 Establish the odour threshold in the form of the 50% detection level - either by searching the literature or if there are conflicting literature values then by paying for the laboratory determination of the odour impact model of the compound.

6.4 Set the ambient air standard at the 50% detection level and invite the polluter to redesign his control system to meet the the standard.

6.5 Continue to monitor the situation through accurate and painstaking monitoring of the complaints and/or source measurements and ambient measurements, keeping the complainants and the source advised of the status of the problem.

Discussion point:

Another point of interest is the use of the normal curve to establish the standard. This approach assumes that the panel is a complete and true sample of the community. That is, that panel response as shown on the odour impact model is identical to community response, and selection of % panel response such as 50% or 25% means that 50, 25 etc. % of the community will be able to detect the odour. This argument means that setting the standard at 50% will protect only 50% of the community from odour insult and there are arguments for setting this number at a lower level. One such argument is for setting the response at 16% because the majority of the people will be between + sigma and - sigma or 68 % - if these people are protected i.e. the average man is protected, then the 16% of people with above average smelling ability will be allowed to suffer the odour insult. As it is these people who most likely to complain, you can see that the problem is not simple.

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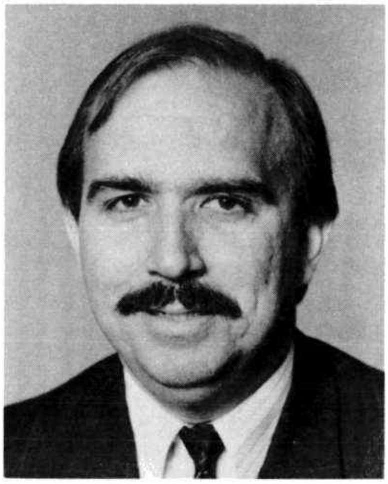
1. GNYP A.W., St. PIERRE C.C., POOSTCHI E.M., "DEVELOPMENT OF REGULATIONS FOR ODOUR CONTROL", FEB. 1986, DEPARTMENT OF CHEMICAL ENGINEERING, UNIVERSITY OF WINDSOR, WINDSOR ONTARIO.

2. TLV'S THLRESHOLD LIMIT VALUES FOR CHEMICAL SUBSTANCES AND PHYSICAL AGENTS IN THE WORK ENVIRONMENT, AMERICAN CONFERENCE OF OF GOVERNMENTAL INDUSTRIAL HYGIENISTS, ACGIH, 6500 GLENWAY AVE., BLDG., D-5, CINCINNATI, OH.45211, 513-661-7881

2. OLFACTOMETRY, ODOUR THRESHOLD DETERMINATION FUNDAMENTALS, VDI 3881. PARTS 1,2 AND 3, VDI VERLAG GmbH, D-4000 DUSSELDORF

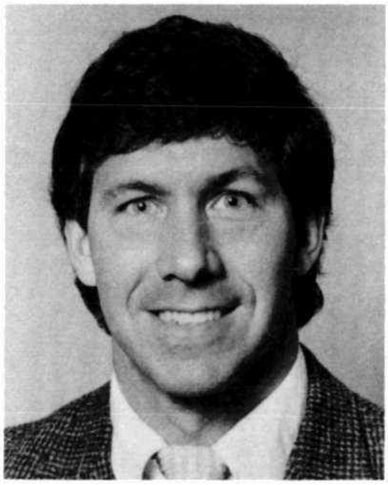
SESSION IV – WATER QUALITY MANAGEMENT

Moderator: George Powell, President
Pollution Control Association of
Ontario, Toronto



D. Vallery, Coordinator, Municipal
Industrial Strategy for
Abatement Advisory Committee
Environment Ontario, Toronto

R.A. Shaver, Ontario Petroleum
Association, Toronto



T.E. McGuire, Coordinator
Water Management, Dofasco Ltd.
Hamilton, Ontario

Dr. S. Stevens, President
Solarchem Inc.
Richmond Hill, Ontario

D.M. Stirrup, Project Engineer
Region of Hamilton-Wentworth
Hamilton, Ontario

THE ROLE AND FUNCTION OF THE MUNICIPAL INDUSTRIAL STRATEGY FOR ABATEMENT ADVISORY COMMITTEE

by
D. Vallery MISA Scientific and Technical Co-ordinator
Ministry of the Environment, Toronto, Ontario

THIS PRESENTATION IS DIVIDED INTO 3 SECTIONS - FIRST A DISCUSSION OF THE CURRENT STATUS OF THE MISA PROGRAM AND WHAT IS CALLED THE MISA CONSULTATIVE PROCESS; SECOND A DESCRIPTION OF THE MAKE-UP AND FUNCTION OF THE MISA ADVISORY COMMITTEE; AND FINALLY COMMENT ON THE ACTUAL INPUT AND CONTRIBUTION THE COMMITTEE MAKES TO THE PROCESS.

SLIDE 1. MISA INTRODUCTION

MISA PROGRAM "Stopping Water Pollution at Its Source"
Regulatory Program - Phased Approach

- **identification through monitoring**
- **control of persistent toxic contaminants and conventionals through the application of limits**

- **"MISA" IS NOT JUST ANOTHER PRETTY ACRONYM. IT IS A VERY SIGNIFICANT COMPONENT OF THE WASTE MANAGEMENT EQUATION IN THIS PROVINCE. IMPLEMENTATION OF THE MISA PROGRAM MAY EVENTUALLY DIRECT THE ENVIRONMENTAL INVESTMENT OF INDUSTRY AND MUNICIPALITIES INTO THE BILLIONS OF DOLLARS.**
- **THE PLAN FOR THIS STRATEGY FOR THE ABATEMENT OF MUNICIPAL AND INDUSTRIAL WASTEWATER EFFLUENTS WAS ANNOUNCED THREE YEARS AGO THIS MONTH IN A WHITE PAPER ISSUED BY THE MINISTER OF THE ENVIRONMENT.**
- **IT CALLED FOR A CONSULTATIVE PROCESS LEADING TO A REGULATORY PROGRAM TO CONTROL AND REDUCE TOXIC CONTAMINANTS IN WASTEWATERS, WHILE CONTINUING AND IMPROVING THE CONTROL OF CONVENTIONAL POLLUTANTS.**
- **INITIALLY NINE SEPARATE MAJOR INDUSTRIAL SECTORS WERE IDENTIFIED, IN ADDITION TO THE MUNICIPAL SECTOR; THE MISA PROCESS WAS ESTABLISHED WHEREBY SEPARATE REGULATIONS WERE TO BE DEVELOPED BY JOINT EFFORT AND NEGOTIATION. THAT SEPARATION REFLECTED THE UNIQUE NATURE OF INDIVIDUAL SECTOR EFFLUENTS AND CONTROLS.**
- **THE MISA PROGRAM WAS TO HAVE TWO COMPONENTS - REGULATIONS LINKED WITH WATER QUALITY IMPACT ASSESSMENTS.**
- **REGULATIONS WERE PLANNED IN A PHASED APPROACH WHEREBY EFFLUENT MONITORING WOULD LEAD TO EFFLUENT LIMITS.**
- **THE MONITORING REGULATIONS REQUIRE DISCHARGERS TO IDENTIFY AND MEASURE CONCENTRATIONS OF TOXIC AND CONVENTIONAL POLLUTANTS IN THEIR EFFLUENTS GENERALLY OVER AN INTENSIVE ONE-YEAR PERIOD OF SELF-MONITORING WHICH IS AUDITED BY THE MINISTRY; MONITORING REGULATIONS SPECIFY SAMPLING, ANALYTICAL AND DATA REPORTING REQUIREMENTS.**
- **THE SUBSEQUENT SECTOR-SPECIFIC 'LIMITS' REGULATIONS WILL SPECIFY REQUIRED EFFLUENT CONCENTRATIONS AND LOADINGS BASED ON BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE**

SLIDE 2. MISA PROGRAM CHRONOLOGY

CHRONOLOGY

o	**MISA WHITE PAPER**	**June 1986**
o	**Industrial Sectors**	
	JTC Establishment	**1986**
	- preregulation monitoring	
o	**Municipal Sector JTC est.**	**1987**
o	**Monitoring Regulations**	
	- Promulgation Targets	**July 88 to Oct 89**
o	**Limits Regulations**	
	- Issues Resolution	**by Dec 89**
	- Prolulgation Targets	**April 91 to July 92**

- **AS THIS SIMPLIFIED CHRONOLOGY SHOWS, JOINT TECHNICAL COMMITTEES TO DEVELOP REGULATIONS FOR EACH OF THE TEN SECTORS WERE ESTABLISHED IN 1986 AND 1987; VOLUNTARY PRE-REGULATION MONITORING PROGRAMS WERE UNDERTAKEN TO INCLUDE INITIAL WASTEWATER CHARACTERIZATION AND VARIABILITY ASSESSMENT.**
- **MONITORING REGULATIONS FOR ALL SECTORS ARE TO BE IN EFFECT BETWEEN JULY OF 1988 AND THE END OF THIS YEAR.**

SLIDE 3 MISA PROGRAM STATUS 1

MISA MONITORING REGULATIONS
INDUSTRIAL SECTORS

- Regulations Promulgated for 2 Sectors
- Draft Regulations for Public Review 5 Sectors
- Draft Regulations pending for Public Review by September - 2 Sectors

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- MONITORING REGULATIONS ARE NOW IN EFFECT FOR TWO INDUSTRIAL SECTORS-PETROLEUM REFINERIES AND ORGANIC CHEMICAL MANUFACTURERS; MONITORING HAS ACTUALLY STARTED AT PETROLEUM REFINERIES; THE IRON AND STEEL SECTOR REGULATION IS TO BE OFFICIALLY "PROMULGATED" THIS MONTH; THE FINAL SIX INDUSTRIAL REGULATIONS WILL BE IN EFFECT BY THE END OF THIS YEAR.

SLIDE 4 MISA PROGRAM STATUS 2

MISA STP MONITORING REGULATION
MUNICIPAL SECTOR

- Draft Regulation for Public Review due in September

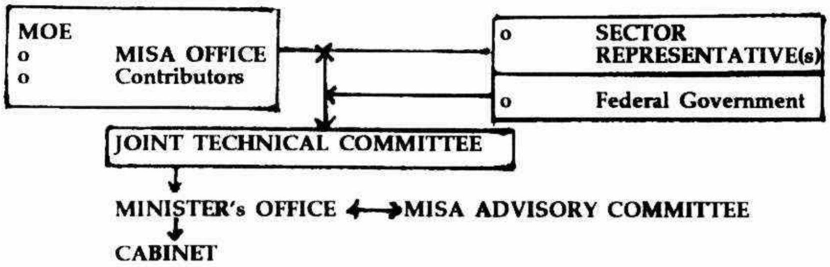
MUNICIPAL SEWER USE PROGRAM

- White Paper due in summer '89

- FOR THE MUNICIPAL SECTOR, A DRAFT SEWAGE TREATMENT PLANT MONITORING REGULATION WILL BE TABLED FOR PUBLIC REVIEW IN THE FALL.
- AS WELL, A WHITE PAPER ON SEWER USE CONTROL WILL BE RELEASED THIS SUMMER, DETAILING THE MINISTRY'S INTENDED PROGRAM AS A FOLLOW-UP TO THE DISCUSSION PAPER RELEASED LAST SEPTEMBER. BASIC ELEMENTS OF THE CONTROL STRATEGY IS THE PRINCIPLE OF 'CONTROL AT SOURCE' AND DISCHARGE AND LOCAL LIMITS APPLIED TO INDIVIDUAL SEWER USERS. THE SEWER USE PROGRAM WILL LIKELY BE STAGED AND APPLY INITIALLY TO SEWERED MUNICIPALITIES WITH POPULATIONS OVER A THRESHOLD LEVEL. GOVERNMENT COSTS ALONE OF THE INITIAL PHASE SEWER USE PROGRAM MAY BE IN THE 50 MILLION DOLLAR RANGE, INCLUDING ENFORCEMENT AND INITIAL CAPITAL COSTS, AND OPERATING EXPENDITURES.

SLIDE 5 THE MISA PROCESS

THE MISA PROCESS



MOE
- MISA OFFICE
- Contributors

- SECTOR REPRESENTATIVE(s)
- Federal Government

JOINT TECHNICAL COMMITTEE

MINISTER's OFFICE ⟷ MISA ADVISORY COMMITTEE

CABINET

- THIS IS A SIMPLIFIED DIAGRAM OF THE SO-CALLED MISA PROCESS. IT IDENTIFIES THE MAIN PLAYERS IN THE CONSULTATIVE APPROACH; ONE PLAYER NOT SPECIFCALLY DIAGRAMMED IS ENVIRONMENT CANADA, WHICH HAS PROVIDED VERY VALUABLE SUPPORT THROUGHOUT THE MISA EXERCISE.
- THE PIVOTAL GROUP IN THE PROCESS IS THE JOINT TECHNICAL COMMITTEE, WHERE THE BULK OF THE NEGOTIATION AND REGULATORY DEVELOPMENT OCCURS.
- THE MINISTRY BUDGET FOR THE MISA PROGRAM IN 1989-1990 IS $ 21.5 MILLION DOLLARS WITH A STAFF COMMITMENT OF 258 PERSONS. A SIMILAR RESOURCE COMMITMENT IS MADE BY THE OTHER MISA PARTICIPANTS.
- AS AN ASIDE, THE SUCCESS OF THE MISA PROGRAM TO DATE IN THE NEAR COMPLETION OF THE MONITORING PHASE IS TO THE CREDIT OF THE JOINT TECHNICAL COMMITTEES. THE DEDICATION AND HARD WORK OF THE INDUSTRIAL AND MUNICIPAL SECTOR REPRESENTATIVES, AND THE MINISTRY STAFF HAS BUILT A MOMENTUM WHICH WILL HOPEFULLY CONTINUE INTO THE SECOND STAGE OF LIMITS REGULATIONS. THE CONSULTATIVE PROCESS HAS EVOLVED, AND ON THE WHOLE HAS SUCCEEDED BY A DEVELOPING TRUST AND A COMMITMENT TO CONTINUING DIALOGUE.

- REGULATION DEVELOPMENT FLOWS FROM TOP TO BOTTOM IN THE DIAGRAM. FOLLOWING THE APPROVAL OF CABINET AND THE REGISTRAR OF REGULATIONS, MISA REGULATIONS TAKE EFFECT.
- THE MISA ADVISORY COMMITTEE, THE SUBJECT OF THE REMAINDER OF MY PRESENTATION, CARRIES ON ITS ADVISORY FUNCTION DIRECTLY UNDER THE AUTHORITY AND DIRECTION OF THE MINISTER.

SLIDE 6 MAC TERMS OF REFERENCE

MISA Advisory Committee
TERMS OF REFERENCE

at the request of the Minister

1. **Review Draft Regulations**
2. **Liaise and Work with Technical Committees**
3. **Regulations - Provide Advice and Recommendations**
4. **Related Matters - Provide Advice**

- THE MISA ADVISORY COMMITTEE WAS ESTABLISHED AS PART OF THE CONSULTATIVE PROCESS, IN NOVEMBER OF 1986 PRIMARILY TO PROVIDE THE MINISTER OF THE ENVIRONMENT WITH INDEPENDENT EXPERT ADVICE ON THE CONTENT OF THE DRAFT MISA REGULATIONS.
- EIGHT MEMBERS WERE APPOINTED, AND ARE CONSIDERED INDEPENDENT, REPRESENTING THEIR INDIVIDUAL EXPERTISE AND EXPERIENCE.
- THE ADVISORY COMMITTEE IS BOUND TO ITS TERMS OF REFERENCE BY THE ORIGINATING ORDER-IN-COUNCIL AND A 'MEMORANDUM OF UNDERSTANDING' SIGNED BY THE MINISTER, DEPUTY MINISTER AND COMMITTEE CHAIRMAN.
- THE MEMORANDUM OF UNDERSTANDING BINDS THE COMMITTEE TO REVIEW DRAFT REGULATIONS AND PROVIDE ITS ADVICE IN CONFIDENCE TO THE MINISTER.
- IN PRACTICE, THE ADVISORY COMMITTEE'S ADVICE IS SHARED BETWEEN MISA PARTICIPANTS IN CONFIDENCE, AND IS CONSIDERED AND RESPONDED TO BY THE JOINT TECHNICAL COMMITTEE PRIOR TO THE FURTHER ADVANCEMENT OF THE REGULATION IN THE PROCESS.

SLIDE 7 MAC MEMBERSHIP

CHAIRMAN	**- Jim MacLaren**
VICE-CHAIRPERSONS	**- Isobel Heathcote** **- Kai Millyard**
PERMANENT MEMBERS	**- Harvey Clare** **- Paul Hebert** **- Joanna Kidd** **- Don Mackay** **- Paul Muldoon**

- THIS LIST IS THE CURRENT PERMANENT LIST OF ADVISORY COMMITTEE MEMBERS.
- CHAIRMAN, JIM MACLAREN, BRINGS OVER 40 YEARS OF EXPERIENCE IN ENVIRONMENTAL ENGINEERING, AS WELL AS A CHARACTERISTIC ENGAGING AND STRAIGHTFORWARD APPROACH.
- THE OTHER MEMBERS INCLUDE:
  -VICECHAIR DR. ISOBEL HEATHCOTE OF THE UNIVERSITY OF TORONTO ENVIRONMENTAL STUDIES;
  -VICECHAIR KAI MILLYARD, CURRENTLY RESEARCH DIRECTOR OF FRIENDS OF THE EARTH, Ottawa
  -HARVEY CLARE, RETIRED ENVIRONMENTAL PROTECTION COORDINATOR, IMPERIAL OIL
  -DR. PAUL HEBERT, PROFESSOR OF BIOLOGY AND ACTING DIRECTOR OF THE GREAT LAKES INSTITUTE, UNIVERSITY OF WINDSOR.
  -JOANNA KIDD, ENVIRONMENTAL CONSULTANT AND FORMER RESEARCHER, POLLUTION PROBE
  -DR. DON MACKAY, PROFESSOR OF CHEMICAL ENGINEERING AND ENVIRONMENTAL STUDIES AT THE UNIVERSITY OF TORONTO
  -PAUL MULDOON, ENVIRONMENTAL LAWYER CURRENTLY WORKING WITH THE CANADIAN INSTITUTE OF ENVIRONMENTAL LAW AND POLICY.
- FROM THIS LIST, YOU CAN SEE THE WIDE BACKGROUND OF EXPERTISE AND EXPERIENCE AVAILABLE TO THE ADVISORY COMMITTEE

SLIDE 8 MAC MEMBERSHIP 2

MAC MEMBERS
when specific Regulations Tabled

- National & Provincial Associations representing Industrial Sectors
- Association of Municipalities of Ontario and the Municipal Engineers Association representing the Municipal Sector

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o THE COMMITTEE IS ALSO COMMITTED TO INCLUDING A FULL MEMBER REPRESENTATIVE OF EACH SECTOR, WHEN A SPECIFIC REGULATION HAS BEEN REFERRED FOR REVIEW.

o THE COMMITTEE HAS HAD THE PRIVILEGE OF INCLUDING A GROUP OF DEDICATED INDIVIDUALS REPRESENTING THE INDUSTRIAL SECTORS. INCLUDED IN THIS GROUP IS RAY SHAVER, THE NEXT SPEAKER ON THE PROGRAM, WHO REPRESENTED THE PETROLEUM REFINERY SECTOR AT THE ADVISORY COMMITTEE.

o AS AN ADDITION TO THE CONSULTATIVE PROCESS, THE MISA ADVISORY COMMITTEE SENDS AN OBSERVER TO JOINT TECHNICAL COMMITTEE MEETINGS, IN AN EFFORT TO KEEP THE ADVISORY COMMITTEE BRIEFED ON THE STATUS OF DELIBERATIONS, AND TO PROVIDE INPUT TO THE JOINT TECHNICAL COMMITTEE DELIBERATIONS FROM THE PERSPECTIVE OF THE MISA ADVISORY COMMITTEE WHERE POSSIBLE.

o THE ADVISORY COMMITTEE MAINTAINS ITS OWN OFFICES, AND OPERATES ON ANNUAL EXPENDITURES OF APPROXIMATELY $ 180,000. GENERALLY, EACH PERMANENT MEMBER DEVOTES FROM 2 TO 4 DAYS PER MONTH TO COMMITTEE BUSINESS, WHILE THE CHAIRMAN IS COMMITTED ON AVERAGE 7 DAYS PER MONTH.

o SINCE ITS ESTABLISHMENT, THE COMMITTEE HAS MET ON 48 OCCASIONS, REVIEWING CONCEPTUAL AND DRAFT REGULATIONS FOR EIGHT SECTORS TO DATE.

SLIDE 9 FORMS OF MAC INPUT - REGULATIONS

MAC INPUT - MONITORING REGULATIONS

Technical Concerns
o monitoring schedules
o analytical requirements
o data requirements and use
o toxicity testing

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o FOR EACH OF THE EIGHT DRAFT REGULATIONS REVIEWED TO DATE, THE ADVISORY COMMITTEE HAS PREPARED A DRAFT REPORT, ACHIEVED AGREEMENT BETWEEN MEMBERS INCLUDING THE SECTOR REPRESENTATIVE AND HAS PROVIDED ITS ADVICE DIRECTLY TO THE MINISTER.

o THE COMMITTEE'S TECHNICAL AND SCIENTIFIC CONCERNS MAINLY HAVE RELATED TO THE FOUR AREAS IDENTIFIED.

o THESE CONCERNS AND THE ASSOCIATED RECOMMENDATIONS THAT HAVE BEEN MADE TO THE MINISTER HAVE GENERALLY BEEN ADEQUATELY RECEIVED AND DEALT WITH BY THE JOINT TECHNICAL COMMITTEES AND THE MINISTRY.

o THE COMMITTEES EXPRESSED CONCERNS HAVE RELATED TO THE CRITERIA AND CONSISTENCY IN DEVELOPING THE MONITORING SCHEDULES FOR EACH SECTOR; TO THE ADEQUACY OF TOXICITY TESTING AND ANALYTICAL REQUIREMENTS TO MEET THE NEEDS OF LIMIT SETTING - THE COMMITTEE HAS ALSO CONTINUING CONCERN OVER THE NEED FOR SPECIFIC STATISTICAL CRITERIA FOR THE ASSESSMENT OF MONITORING DATA.

SLIDE 10 FORMS OF MAC INPUT - MISA PROGRAM

o Equal and Sequential Implementation
o Regulation Formatting
o Project Management
o Statistical Needs
o Program Integration

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o THE MISA ADVISORY COMMITTEE HAS ALSO REVIEWED DRAFT REGULATIONS FROM THE POINT OF VIEW OF PROGRAM ISSUES. THE COMMITTEE HAS EXPRESSED CONCERN OVER THE CONSISTENCY BETWEEN REGULATIONS, AND THE EQUITABLE TREATMENT OF ALL SECTORS.

o THE COMMITTEE HAS ALSO SEEN THE NEED AND RECOMMENDED A STRONG, WIDELY READ PROJECT MANAGEMENT SYSTEM FOR THE MANY SUB-COMPONENTS OF THIS VERY COMPLICATED MISA PROGRAM.

- ANOTHER RECOMMENDATION HAS BEEN AN EXPANDED COMMITMENT TO PUBLIC COMMUNICATIONS WHICH THE COMMITTEE FEELS IS VITAL TO MAINTAINING A PROPER DIALOGUE AND TO ENSURE VALUABLE PUBLIC RESPONSE WHEN PROGRAM RELATED DOCUMENTS ARE ISSUED FOR PUBLIC COMMENT.
- ANOTHER CONCERN HAS BEEN THE NEED TO INTEGRATE COMMITMENTS GOVERNMENTS HAVE MADE IN OTHER FORUMS WITH THE REQUIREMENTS OF THE MISA PROGRAM. EXAMPLES OF THESE COMMITMENTS ARE THE GREAT LAKES WATER QUALITY AGREEMENT BETWEEN CANADA AND THE US, AND THE FREE TRADE PACT.

SLIDE 11. FORMS OF MAC INPUT - MUNICIPAL

- Request for Comment
- Discussion Paper:
  Controlling Industrial Discharges to Sewers
- Initial Response
  - need for effective communication and attention to process
  - project management
  - funding aspects critical
  - sequencing of monitoring
  - sludge management / waste reduction

- THE MISA ADVISORY COMMITTEE HAS ALSO HAD SOMETHING TO SAY ABOUT THE DEVELOPMENTS WITHIN THE MUNICIPAL SECTOR, EVEN THOUGH NO OFFICIAL REGULATIONS HAVE BEEN REFERRED TO THE COMMITTEE.
- IN EARLY 1987, THE MINISTER REFERRED A POLLUTION PROBE BRIEF ENTITLED "PLUGGING THE 11,000 LOOPHOLES IN MISA" TO THE ADVISORY COMMITTEE FOR ITS ADVICE. THE COMMITTEE RESPONDED ON SEVERAL OCCASIONS TO THIS ISSUE OF SEWER USE CONTROL, MOST RECENTLY IN ITS FEBRUARY 1989 SUBMISSION ON THE MINISTRY'S DISCUSSION PAPER "CONTROLLING INDUSTRIAL DISCHARGES TO SEWERS". A RESPONSE TO THIS ADVICE IS EXPECTED SHORTLY IN A MINISTRY WHITE PAPER.
- IN ITS SUBMISSION AND IN SUBSEQUENT DISCUSSIONS WITH THE MINISTRY, THE ADVISORY COMMITTEE HAS RECOMMENDED THAT A STRONG SEWER USE PROGRAM PROCEED AND HAS EXPRESSED CONCERNS OVER THE FUNDING AND ENFORCEMENT ASPECTS OF SUCH A PROGRAM,
- THE COMMITTEE HAS ALSO EXPRESSED CONCERNS OVER THE MUNICIPAL REGULATORY PROCESS AND THE NEED FOR OPEN AND FREQUENT COMMUNICATION, A DETAILED PROJECT MANAGEMENT REPORTING SYSTEM,
- THE COMMITTEE HAS ALSO QUESTIONED THE REGULATORY PLAN FOR DEALING WITH AN EXPECTED INCREASE IN THE VOLUME AND CONTAMINANT CONCENTRATION OF SLUDGES, COMING FROM BOTH MUNICIPAL AND INDUSTRIAL SOURCES.
- ASSURED THAT MANY OF THESE CONCERNS WILL BE ANSWERED IN THE PENDING WHITE PAPER.

SLIDE 12 ISSUES RESOLUTION PROCESS

PARTIAL LIST OF ISSUES leading to
EFFLUENT LIMITS REGULATIONS

1. USE OF MONITORING DATA
2. BATEA - Principles for Selection
   - "EA Criteria"
3. CRITERIA FOR LIMITS PARAMETERS
4. SETTING LIMITS
5. TOXICITY
6. MONITORING UNDER LIMITS
7. LIMITS IMPLEMENTATION

PROCEDURE and PARTICIPANT INPUT

- AS MENTIONED EARLIER, THE CONSULTATIVE PROCESS HAS EVOLVED, AND THAT EVOLUTION IS CONTINUING IN THE FRAMEWORK OF AN "ISSUES RESOLUTION PROCESS".
- A NUMBER OF 'ISSUES' HAVE BEEN LISTED AND DESCRIBED BY THE MINISTRY (A SELECTION OF MAJOR ISSUES IS LISTED ON THIS SLIDE) THESE ISSUES ARE PROPOSED AS BEING COMMON TO ALL SECTORS AND REQUIRE RESOLUTION PRIOR TO ADOPTING LIMITS REGULATIONS ON A SECTOR-BY-SECTOR BASIS. CONSULTATION IS ONGOING AT THE PRESENT TIME TO FINALIZE A LIST, WORKING GROUPS TO DEAL WITH THE ISSUES, AND THE FORM OF REPRESENTATION TO BE TAKEN BY THE STAKEHOLDERS, INCLUDING INDUSTRY, MUNICIPALITIES, THE FEDERAL GOVERNMENT, AND THE MISA ADVISORY COMMITTEE
- THE ADVISORY COMMITTEE LOOKS FORWARD TO AN ACTIVE ROLE IN THIS 'ISSUE RESOLUTION' PROCESS.

SLIDE 13 OUTLOOK / CONCLUSIONS

MISA ADVISORY COMMITTEE OUTLOOK
PROVIDING:

- **OPPORTUNITY FOR CRITICAL ASSESSMENT** prior to public review
- **OPPORTUNITY TO REACH CONSENSUS WITHIN PROCESS**
- **OPPORTUNITY FOR COMMUNICATION**

- THIS PRESENTATION HAS BEEN DRIECTED AT GIVING THE CONFERENCE AN UNDERSTANDING OF THE ROLE OF THE ADVISORY COMMITTEE.
- THIS CONSULTATIVE PROCESS HAS BEEN A MOST WORTHWHILE EXPERIENCE, AND DESERVES OUR ATTENTION AND CONTINUING SUPPORT.
- THE ADVISORY COMMITTEE HAS PLAYED AN IMPORTANT ROLE IN EXTENDING OPPORTUNITIES FOR CRITICAL REVIEW OF TECHNICAL APPROACHES AND IN EXPANDING OPPORTUNITIES FOR COMMUNICATION BETWEEN MISA STAKEHOLDERS.

REFINERY EXPERIENCE WITH THE MISA MONITORING REGULATION

by

R. A. Shaver, Ontario Petroleum
Association, Willowdale, Ontario

I appreciate the opportunity to talk to you to-day on behalf of the Ontario Petroleum Association.

I will review briefly the development of the philosophy of Environmental protection in the Petroleum industry over the past 30 years or so, with special emphasis on the Refineries in Ontario. This background will, I believe, help you understand our approach to current day environmental issues, specifically the Ontario MISA program.

I will then move on to talk about the experience our Sector has had in the development of the MISA General and Monitoring Regulations and in the first six months of actual monitoring; including some lessons learned and what we see ahead of us in the MISA program.

About 30 years ago the Ontario Water Resources Commission (OWRC) started the annual Industrial Waste Conferences, the forerunner to the Ontario Waste Management Conference to-day. The purpose of the OWRC Conference was to afford an opportunity for industry, government and environmental interest groups to meet and to discuss and to search for solutions to environmental problems.

What was true then is even more germain to-day. The problems are more complex and as a consequence so are the solutions. Simplistic solutions and finger pointing which sound good on T.V. or look good in the headlines really do little to advance the preservation and enhancement of the environment. On the other hand sincere dialogue amongst the stakeholders leading to a thorough understanding of all sides of the issues will bring about the steady movement of society towards the ultimate solutions. This approach might not be news-worthy, but in the long run it is the only effective way to make real progress. Cooperation, not confrontation, is the proven way to go.

Although we have serious environmental challenges before us as Ontarians, Canadians and world citizens, we should not lose sight of the progress which we have made, particularly in Ontario over the past 30 years. Much of that progress was based upon cooperation and trust amongst the various parties. We should remember this approach in devising strategies to solve the environmental issues which lie ahead.

Similarly the role which this conference has played over the years in fostering dialogue among all interested parties should not be underestimated .

Although cooperation is the cornerstone of any successful environmental policy, there are two other essential ingredients which will shape society's drive to protect the environment

- education and,
- science and technology

Both of these activities are necessary if society, as a whole is to understand the real needs of the environment and if effective actions are to be supported. By way of illustration, the several waves of environmental protection action during the past few decades have followed intensified news media coverage and other methods to educate citizens. Furthermore, the current public opinion rating of environment as the foremost public policy issue in Canada is evidence of yet another heightened public awareness of the environment. Much of this awareness has developed as a result of new scientific information. Solutions to the identified problems also draw upon science and technology for answers.

In fact the same science and technology that offer solutions to pollution problems are often painted as the villains in leading us down the path to pollution in the first place. They may not be able to provide all of the answers to all of the problems all of the time, but they may be able to point the way to progress in a shorter time span than is required to change public attitudes and to make lifestyle changes which may be necessary in some cases.

In the petroleum industry those activities began in the late 50's or early 60's as the executive management of some of our companies realized that there was an environmental protection job to be done. "Environmental coordinators," or their equivalent, were born.

We got involved in identifying and solving environmental problems in our plants. The petroleum industry's first biological oxidation unit to treat refinery waste water was commissioned thirty five years ago in 1954. Other refineries installed similar treatment facilities in the early 1960's.

Environmental protection technology was being invented and applied at that time by our industry. At the same time, executive management were becoming educated in environmental affairs, an important beginning.

This led to Canadian petroleum industry discussions in late 1969, which culminated in the formation of the Petroleum Association for Conservation of the Canadian Environment (PACE) in 1970. PACE was set up as an organization that would develop scientific understanding of environmental needs in our industy, and assist in the development of solutions to problems to meet those needs.

The accomplishments of PACE over the years were recognized last week by Environment Canada during the nationally televised Environment Week environmental awards ceremony.

Federal petroleum refinery effluent guidelines were developed with petroleum industry consultation in the mid-70's, which, for Ontario, resulted in ultimate expenditures for effluent water control, of $300 million in today's dollars. These plants have been operated since the mid-70's and updated and improved up to the present time.

Having properly managed the so-called conventional pollutants in our refinery effluents by the mid to late 70's, the refining industry, through PACE, began to consider in 1977-78, the possibility of trace toxic contaminants in our refinery effluents. By 1980 the first research started. Environment Canada responded to our invitation and participated in this work.

A total of five projects were completed by 1985 and the reports have been published and are available to the public. This information was used by the Ontario Ministry of the Environment at the start of the MISA program in 1986.

With this background of achievement by the refining industy, it should not be surprising that the Ontario Petroleum Association believed that the MOE initiative in developing the MISA program was timely and the Association fully supported it.

In fact, the Hon. Jim Bradley, Minister of the Environment, chose our sector to lead the way in the line-up of industrial sectors to work the MISA program precisely because of our experience, track record and positive attitude on environmental protection matters.

The General and Monitoring Regulations of the MISA program for the Petroleum Sector were promulgated in July 1988 and the actual monitoring commenced on December 1, 1988. Thus we are now nearly half way through the monitoring period.

In reviewing our experience in the development of the Regulations and with six months of monitoring, I need to emphasize that the regulation is highly technical and operationally complex. For these reasons, there is a very large risk of minor variances occurring. I speak of variances which do not in any way threaten or affect the ability of the program to achieve the MISA objective of supplementing the comprehensive data base which already exists on refinery effluents.

I stress this point to be sure that you understand our position. If a few mistakes are made in the many thousands of sampling, analytical and reporting activities that must occur each month around the clock in each refinery under the MISA program, they should be handled with administrative discretion and not form the basis for a record of poor performance by the plant site.

One of the basic principles of the environmental philosophy of our industry is equitable regulatory treatment, among members of our industry and across industries and municipalities. While we believe in the exercise of technical and environmental protection judgment in the administration of the regulations, we would fully support action by the Ministry to call to account anyone who may persistently, flagrantly and knowingly flout the spirit and letter of the MISA program.

The costs of the monitoring program for our industry have been substantial. We have spent over four million dollars on it up to the end of 1988. This includes:

- $500,000. for research on the characteristics of our effluents between 1981 and 1986.

- $294,000. on eight technical projects to provide information for the regulations, for example: development of a training program for our waste water treatment plant operators, a round robin testing program for conventional effluent parameters, a pre- monitoring study of the effluents of two of our refineries, and a round robin to assess the Ministry's acute Daphnia Magna test protocol. Our technical projects are done in cooperation with PACE, (our national environmental group).
- 850 person days of effort by industry environmental and technical specialists.
- $1,700,000 for capital equipment.
- $1,100,000 for refinery operating costs for the monitoring program.

- $150,000 in other operating costs including the development of a communications program. You will recall that a few moments ago I referred to the importance of education. We believed that a communications program was necessry to inform selected audiences about our position and status with respect to the MISA program. A communications consultant was hired and an attractive brochure was prepared. Copies are available if anyone in the audience would like to have one.

We estimate that our costs in 1989 to complete this phase of the program will be about another $2 million, which will bring the total to over $6 million.

Looking back over 1988, one reality stands out; that is the high level of effort required to work with the Ministry to develop the regulations and to implement and supervise them in the refineries. This should not be surprising, as I mentioned a few moments ago that the regulations are highly technical and very complex and they involve a great many individual operations. Our advice to the other sectors would be not to underestimate the work load required.

To be more specific about the lessons we have learned so far,

-- Designate full time dedicated MISA personnel for both operations and coordination.

-- Maximizing on-site vs outside testing to minimize the occurence of technical operating variances due to the additional steps required.

-- Start early to install the equipoment and train the personnel to handle the sampling and testing requirements of the regulation.

-- Carefully review the selection and use of equipment for automatic sampling. There have been substantial maintenance and fouling problems in our refineries with this type of equipment.

-- Provide trained back-up for all activities.

-- Carefully review the capabilities of outside contract laboratories to ensure adequacy of the data and timely delivery of it.

-- Integrate MISA Monitoring Requirements with normal operations being carried out on the site.

-- Watch out for differences in the requirements for MISA sampling and testing that might cause confusion with that which was historically done at the site.

-- Take great care with the data handling and especially input to the MISA Data Entry System, known as the MIDES program. It is not user friendly.

What does the MISA program hold for us in the future? There are a number of issues that will require substantial effort during and beyond 1989, including development of the principles for the economic analysis for the level of treatment to be required under the criterion of Best Avilable Technology Economically Achievable (BATEA).

Another future issue is development of the technical requirements of BATEA. It is important here to recognize that by definition, BATEA is a level of treatment to a given standard. It is NOT zero discharge.

The concept of zero discharge, although superficially quite attractive, is impossible to achieve, short of total plant shut down. Or in the case of municipal treatment plants, total shut down of society. The reason for this is that analytical chemists are continually analyzing for chemical compounds at ever diminishing minute concentration levels. We are already working at the parts per quadrillion level in some cases, i.e. an equivalent of about 1-1/2 inches in 400,000 times around the equator.

In setting technical standards for effluent quality, we believe that principles upon which the decisions will be based must stand the test of fairness and equal application across all industrial sectors and municipal discharges. It will be difficult enough for some industrial sectors to "measure up" to MISA requirements that will be set in the future. It may be even more difficult for political or fiscal reasons to bring municipalities up to state-of-the-art treatment. The elimination of combined storm and sanitary sewers is a formidable task in itself.

When all industries and municipalities have state-of-the-art treatment facilities in place, we agree with the original MISA White Paper that the emphasis should shift away from more and more treatment of effluents towards deciding upon a treatment level based upon actual environmental impact. Additional treatment should be driven by the quality needs of the receiving waters and the effects of effluent water discharges upon those needs and not by choosing arbitrary treatment levels.

A very significant amount of effort will be required this year to develop an information management system to assemble and analyse the huge amount of raw data which we are collecting every day..

We have about a dozen other projects under way which time does not permit me to discuss today. Suffice it to say, we expect that the human resources requirement will not decrease over that which was needed last year.

I have purposely left the most important aspect of the development of the MISA program to the last; namely, the consultative process. It is critical to the success of the MISA program, measured both by timeliness and technical achievement, that all of the affected parties have proper opportunities to contribute to the regulation development process.

Who are the affected parties? They are nine industrial sectors, the municipalities, environmental interest groups, the public, various groups within the Ontario Ministry of the Environment, as well as the federal Government. These parties all have viewpoints that are important to the MISA program on technical, policy, legal and political grounds.

It should be evident that to achieve true and effective consultation is difficult, but the rewards for the Ministry of the Environment, and all the other parties, are well worth the hard work; and hard work it is for all parties to maintain the consultative process under the tight schedule necessary to complete complex regulations. The consultation process is probably more difficult to maintain and to conduct successfully than any other critical aspect of the program.

What are the expected rewards? A practical, effective, legally binding regulation that will minimize or eliminate unproductive activities in the implementation stage that would otherwise result and which may have little or nothing to do with actually protecting the environment. In fact such activities in themselves can cause undue risks to the environment by diverting the attention away from what should be the top environmental priorities.

It is fair to say that we have all been involved in a new and unique exercise in developing the consultation process and it has not been without some serious difficulties. We are currently actively participating in a multi-stakeholder dialogue on the subject, so that together we can produce the final phase two product of the MISA program in an effective, efficient and timely fashion.

In conclusion, our industry continues to support the goals of the MISA program. The philosophy behind it is consistent with the approach we, in the petroleum refining industry, have used for many years in our waste water treatment; that is to say a combination of technical and environmental factors. We are prepared to continue to work with all of the stakeholders to ensure that our plant effluents meet the environmental quality needs of the receiving waters.

AN INDUSTRIAL APPROACH TO WATER CONSERVATION

T. E. McGuire, Co-ordinator of Water Management

Dofasco, Inc., Hamilton, Ontario

INTRODUCTION

Dofasco is a fully integrated iron and steel producer with coke ovens, oxygen steelmaking, continuous casting, hot and cold rolling facilities, and a variety of subsequent finishing processes. The company is located in the City of Hamilton on the south shore of Hamilton Harbour.

With Canada having more freshwater lakes than any other country in the world, and with Dofasco located adjacent to one of these, it may seem odd to be even discussing water conservation. However, as the recent Inquiry on Federal Water Policy found, large quantities of available water must not render the nation complacent in its attitude toward water quality. The conservation of water goes hand in hand with maintaining a high quality of water.

The major driving force for maintaining water quality and controlling discharges to surface water bodies has come from provincial legislation - the Environmental Protection Act and the Ontario Water Resources Act. MISA - short for Municipal-Industrial Strategy for Abatement - is a new control program under the Ministry of the Environment which has set out to strengthen the legislation by developing a regulation to specifically reduce the discharge of toxic substances.

Locally, the Hamilton Harbour has been identified by the International Joint Commission as one of 17 areas of water quality concern in Ontario. The Federal and Provincial governments, in co-operation with the various industrial and community stakeholders, have committed themselves to developing Remedial Action Plans (RAP's) for Hamilton

Harbour and the other areas. Dofasco has become an active participant or stakeholder in the development of the RAP for Hamilton Harbour. One major stakeholder goal deals with the need for taking a loadings-target approach for discharges to the Harbour. As I will convey in this paper, this goal is entirely in line with Dofasco's own water management and conservation approach.

WATER USE AT DOFASCO

The steel industry is a major user of water because of the nature of the product being manufactured. Incredible heat is required in the process and necessitates extensive cooling. Dofasco uses about 20,500 U.S. gallons per ton of steel produced. This is substantially lower than the 55,000 U.S. gallons per ton stated in the Provincial Government's 1986 publication - "Water Quantity Resources of Ontario". Between 25 and 35% of the water used comes into direct contact with raw materials, gases or products. Adequate capacity has been installed at Dofasco to treat all contact water. Nearly all these treatment facilities meet or better the Provincial Ministry of Environment requirements.

The other 65 to 75% of Dofasco's water distribution is used for the purpose of indirect cooling. This water does not come into contact with polluting elements and is returned to the Harbour untreated. Only 2% of Dofasco's total water intake is consumed by evaporation in the steelmaking process. This represents only half of the 4% rate stated for the Major Industrial Sector in the above cited Provincial publication.

Approximately 97% of the water used at Dofasco is pumped directly from the Harbour. The other 3% is purchased from the city. Since 1974, we have reduced our city water usage by 62% from 12,500 U.S. gpm to 4,800 U.S. gpm (Figure 1). An excellent incentive to do this has been the high cost of purchasing city water. While Dofasco's bay water intake presently costs 5.7 million dollars per year, it costs the company 4.4 million dollars to purchase 32 times less city water.

Figure 2 shows Dofasco's water distribution by plant area. The Utilities Department Boilerhouses use the most water at 30% of the company's total, but essentially 100% of it is used for cooling purposes. The largest user of contact water is our Hot Rolling Division where almost ten and a half billion gallons per year comes into contact with either the slab or strip during cooling or descaling. The other major users of water are the Blast Furnaces for iron production and the Melt Shop for steelmaking. Significant reductions in water usage have been achieved in all of these plant areas; and how these reductions have been attained is discussed below.

THE 4 "R'S"

The conservation of any resource such as water is best discussed in terms of the 4 "R's" - Recycle, Recovery, Reuse and Reduction. Reduction is actually a function of the first three R's since the implementation of recycle, recovery and reuse ultimately results in a reduction in water usage. Reduction, however, can be achieved without having to go to recycle, recovery or reuse.

It became apparent to Dofasco in the 1960's that if efforts were made in our water management programs to increase the 4 "R's", then it followed that lower effluent discharges would result. With the lower discharge flows, the total loading of pollutants from these discharges would also be reduced and the water quality of the receiving body - Hamilton Harbour - would improve.

This point is clearly shown in Figure 3 for particulate which is a target pollutant identified by the RAP stakeholders. The hatched line shows a definite downward trend in the discharge of particulate to the Hamilton Harbour by Dofasco processes over the past 14 years.

Similarly, a significant downward trend in the discharge of ammonia - another RAP target pollutant - is largely the result of implementing the 4 "R's" (Figure 4). Process optimization and new installations such as our Zimpro-Ammonium Sulphate Plant have permitted the recovery of ammonia, and thereby, a reduction in ammonia effluent discharged to the Harbour.

WATER CONSERVATION TECHNIQUES USED AT DOFASCO

There are eight major water conservation techniques employed at Dofasco. These include:

- cooling towers/heat exchangers (recycle);
- contact process water conditioning (recovery; recycle);
- condensation of water vapour (recovery; recycle);
- evaporative cooling (recovery; reduction);
- cascade from higest to lowest quality water users (reuse);
- counterflow rinsing (reuse);
- thermostatic control (reduction);
- preventative maintenance (reduction).

1. Cooling Towers

Dofasco has 12 cooling towers of varying capacities and types. Cooling towers are simply a direct heat exchange mechanism whereby air comes into contact with water to cool it, allowing it to be recycled back to the process. Figure 5 shows an induced draft cooling tower where a fan situated at the top draws air up from the bottom of the tower. Cooling takes place by evaporation over the large surface area afforded by the packing. In this case, the flow of water is counter to that of the air.

The cooling tower at the No. 2 Hot Mill Filtration Plant permits recycle of water back to the No. 2 Hot Mill. It is Dofasco's largest cooling tower. It is a cross-flow design and handles a flow of 34,000 gallons per minute.

Without this cooling tower, water recycle to the No. 2 Hot Mill would not be possible. The thermal build-up in the water would exceed the 95°F limit necessary for adequate roll and strip cooling.

Cooling towers are also used in conjunction with non-contact heat exchangers to facilitate the recycle of cooling water. The application shown in Figure 6 is for the cooling water system at the No. 1 and No. 2 Galvanizing Lines. On the closed loop side or primary side, highly conditioned water enters the plate heat exchanger where it transfers heat indirectly to water on the secondary side. The water on the secondary side is "open" or exposed to the outside environment by way of a cooling tower whereby the heat picked up is dissipated. This combined cooling system permits process cooling water entering the heat exchanger at 130°F to be recycled to the Galvanizing Lines at 90°F. Other heat exchanger applications in the plant do not necessarily employ a strict closed loop system but operate on a similar basis with a process cooling fluid on one side of the heat exchanger and recirculating cooling tower water on the other side. All in all, the use of cooling towers and heat exchangers reduces Dofasco's water withdrawal by 41 billion gallons per year, or half of our present water usage.

2. Contact Process Water Conditioning

The second conservation method practiced at Dofasco is contact process water treatment or conditioning. This method permits the recovery of useable water for recycle.

Both the No. 1 and No. 2 Hot Mill Filtration Plant are the 2 major water treatment facilities at Dofasco which allow clean water to be recovered from waste water and recycled back to the mills. The ion exchange system which treats waste chromium rinse waters from the Electrolytic Coating Lines is another important technology which permits the recovery of deionized water and reduces the volume of waste for disposal. Local treatment also occurs at the larger cold rolling mills to lengthen the life of recirculating solutions and rinse waters.

(a) No. 2 Hot Mill Filtration Plant

Figure 7 shows the basic flow schematic for the No. 2 Hot Mill Filtration Plant. Water from the Hot Mill and Caster enters the four settling basins at an average flow of 42,500 gallons per minute. Heavier particles settle to the bottom of these basins while surface oil and debris is skimmed off. The overflow from the settling basins flows to 17 individual dual phase media deep bed filters. Normally 16 of these cells are in the filtering mode while 1 cell is in backwash mode. The filtered water from the bottom of each filter cell enters the wet well. In addition to this, only 800 gallons per minute of clean filtered water is discharged to sewer as blowdown to keep the chemical concentration of the recycle water at an acceptable level. This water is actually lower in particulate than the bay water withdrawn at the pumphouses. Dirty backwash effluent flows from the filter cells into two decant basins where it is pumped back to the settling basins. The cooling tower handles about 80% of the flow into the wet well and ensures that the water returned to the Hot Mill and Caster is less than 95°F. This recycle system means that only 2,500 gallons per minute of make-up water have to be introduced to the system.

(b) Ion Exchange System

The ion exchange system is a specialized treatment system which receives chromium contaminated rinse waters from the Electrolytic Coating Lines at a rate of 130 to 180 gallons per minute (Figure 8). The waste water passes through a primary and subsequent polishing train of cation and anion units to regenerate deionized water which is recycled back to the Electrolytic Lines. Disposal of chromium contaminated waste water is expensive at more than $2.27 a gallon.

In the ion exchange system, as the rinse water passes through the cation resin bed, sodium ions attach themselves to the resin, and hydrogen ions are released. Anions in the rinse water pass through the cation unit unaffected. As the water enters the anion unit, the anions are similarly exchanged. Chromium oxide has a higher affinity for the resin than the hydroxide ions which are released into the water phase. Pure de-ionized water exits from the ion exchange train.

The recovery of de-ionized water from the ion exchange system is worth more than a quarter of a million dollars to Dofasco annually. And with the disposal cost for chromium contaminated waste water at over $2.27 a gallon, chromium electroplating would not be economically feasible without this process.

3. **Condensation of Water Vapour**

Water is also recovered by condensing water vapour from steam and then recycling it. Condensation of water vapour occurs at several locations plant wide including heat exchangers at the Pickle Lines and Electrolytic Lines. The No. 1 and

No. 2 Boilerhouses recover the greatest amount of water by practicing this conservation technique.

Recovery occurs at the Boilerhouses in 3 locations - at the condensers, stage heater and deaerator (Figure 9). The condensers condense 760 gallons per minute of steam used to generate wind from 4 turbo blowers. The turbo blowers supply a blast of oxygen for iron production at the blast furnaces. Water and heat is also recovered from 20,000 lbs/hour of medium pressure turbine exhaust steam used in a feed water stage heater at the No. 2 Boilerhouse. The heat recovered by the feed water is approximately 19.5 million BTU's per hour or 56°F before entering the boiler. Forty gallons per minute is also recovered and recycled to the deaerator. Thirteen percent of the total Boilerhouse steam is used for auxiliary boilerhouse equipment before it is ultimately recovered in the deaerators as low pressure steam. On average, this represents about 260 gallons per minute.

4. Evaporative Cooling

Evaporative cooling is an important mechanism for recovering waste heat and in the process reducing the vast quantities of water which would otherwise have been required for convective cooling. Two areas of the plant which lend themselves to evaporative cooling are the Melt Shop fume collection hoods and the reheat furnaces at the new Caster.

(a) Melt Shop Fume Collection Hoods

The three No. 1 Melt Shop steelmaking furnace hoods were previously cooled convectively with water and required 7,600 gallons per minute each to provide the necessary cooling. The hoods themselves were poorly fitted to the furnace cone and were a major factor in poor emission collection and cleaning.

The new steam hoods require almost 150 times less water to perform the necessary cooling (Figure 10). Feed water from the No. 2 Boilerhouse passes through a deaerator prior to entering a steam drum where it is recirculated through the hoods. Each hood is capable of producing almost 25,000 lbs/hour of steam. The blowdown rate of 3 gallons per minute is negligible compared to the 5,300 gallons per minute discharged from the old system (2,300 U.S. gpm was reused in gas cleaning). The total production of high pressure steam from the three furnaces averages 50,000 lbs/hour. This represents approximately 1.6 million dollars in steam generation annually.

(b) Slab Inside Reheat Furnace

The other major application of evaporative cooling is the reheat furnace system at the No. 1 Caster. Both the skids and the furnace walls are evaporatively cooled as temperatures in the furnace run at 2,350°F.

The two reheat furnaces operate in the same fashion as the steam hoods at the Melt Shop. With furnace refractory functioning at 80% efficiency (upper left of Figure 11), the reheat furnaces are capable of producing more than 100,000 lbs/hour of steam. The 200 gallons per minute which is required for evaporative cooling is 75 times less than the 1500 gallons per minute which would have been required to water cool the furnaces convectively. The total installation cost for an evaporatively cooled system is about 2.9 million dollars more than a convectively cooled one. The steam generated from the evaporatively cooled system can recover this cost difference within one year.

5. Cascade From Highest to Lowest User

Cascading or directing water from processes requiring higher quality water to those having lower quality demands is a commonly practised water reuse technique at Dofasco. The major areas of the plant which employ a cascading water system are the Blast Furnaces, Melt Shops and Hot Mills. The Coke Production area also employs water reuse in its coke quenching practice.

Two of the four Blast Furnaces cascade water from furnace cooling to gas cleaning. Reuse and internal recirculation at the Blast Furnaces account for about 18,000 gallons per minute or almost 40% of the water received by this area of the plant. Similarly, large volumes of water in the order of 10,000 gallons per minute at the Melt Shops are cascaded from gas cooling to gas cleaning in the venturi.

Figure 12 shows how the cascading system is used at the No. 3 Coke Plant. Clean bay water make-up enters the venturi scrubbing system for the coke pushing emissions. As the level in the quench sump becomes low, dirty water from scrubbing system is pumped over to the sump. About four times an hour, a rail car full of red hot coke is dosed with 8,000 gallons of water. Quench water particulate concentrations average 265 ppm, but water quality is not an important consideration for coke quenching.

Another example of water reuse by the cascading technique is shown in Figure 13. Fresh bay water of relatively low temperature and suspended solids is first used to cool the Foundry Powerhouse compressors. It picks up approximately 10°F in temperature before entering its second user - the furnace rolls at the No. 2 Tower Anneal. As a cooling agent, the quality of the water has deteriorated further but is still useful for high pressure strip cleaning at the No. 1 Hot Mill descale area. From its first to third use, the water has gained 45°F and becomes thirty times dirtier.

6. Counterflow Rinsing

Counterflow rinsing is also a conservation technique utilized in reusing water. This technique is employed at the cleaning and finishing lines.

The chromium section at the Electrolytic Lines (Figure 14) shows the strip moving to the right along with solution dragout. Meanwhile, the rinse tanks flow counter to the direction of the strip. The first rinse tank on the left contains the most contaminated water and this is returned to the ion exchange system discussed above. The installation of a counterflow rinse water system can reduce rinse water requirements by over 75%. Squeegee rolls are also used to minimize solution dragout and thereby contribute to the reduction of rinse water make-up.

7. Thermostatic Control

Thermostatic control is a major, but relatively simple, method for reducing water usage. This water conservation technique is employed plant-wide, particularly for oil coolers, and results in about a 10,000 gallons per minute saving. Thermostatic control is a way of ensuring that only sufficient water is being pumped for the purpose of cooling. It works on the same basis as the thermostat for a furnace.

The new caster employs thermostatic control more than any other plant operation. Two closed loop cooling recirculation systems are shown in Figure 15: one of the mould proper and another for the machine which actually redirects the steel slab in a horizontal direction as it is being formed. For effective cooling, water is returned to the mould and machine at 113°F. To maintain this temperature at the return point, a sensor measures the temperature of the closed loop recirculating water which in turn controls a value that increases or decreases the flow of once-through bay water on the secondary side of the heat exchanger.

8. Preventive Maintenance and Other Efforts

Preventive maintenance must be an integral part of any program aimed at water conservation. It is estimated that regular preventive maintenance on pumps, valves, piping and tanks can reduce water wastage by as much as 15%. Each operating department at Dofasco has an assigned maintenance group which carries out this responsibility.

Other efforts directed at water conservation include those undertaken by the Energy Management and Utilities Departments. Energy Management's primary focus is on reducing energy costs, but in the process, water conservation benefits often accrue - for example, examining ways of reducing steam consumption. Special studies are undertaken by the Utilities Department in high usage areas, particularly those where city water is involved. Operating department personnel are also trained to assist Maintenance Departments by making regular shift checks of process components and fixing or reporting problem areas as soon as possible.

Dofasco's suggestion system has also played a part in reducing water usage at Dofasco. For example, a suggestion was made to reuse condenser cooling water as make-up feed water to the Boilers (refer to Figure 9). This water experiences a temperature change of approximately 20°F. By reusing 800 to 1,800 gallons per minute of the heated condenser cooling water, the feed water requirements of the boilers can be met. At the same time, the increased temperature of the feed water entering at the clarifier translates into a 10% lower steam requirement for the deaerators.

FUTURE EFFORTS IN WATER CONSERVATION

Efforts at reducing water usage in the future will focus on high contact water users such as the Blast Furnaces, No. 1 Hot Mill and the two Steelmaking Shops.

Dofasco's Engineering Department is presently undertaking a study to determine the feasibility of reusing up to 7,500 gallons per minute of contact water for roll cooling at the No. 1 Hot Mill.

An extensive recycle program for Blast Furnace gas cleaning and cooling water is also now being engineered and installed. This program will result in 20,000 gallons per minute being conditioned, cooled over a cooling tower and recycled back to the Blast Furnaces. The feasibility of a similar recycle project for the Steelmaking Shops is being discussed as well.

Cooling towers for non-contact water are also being proposed for new facilities such as the Cold Mill complex and mould cooling at the casters should a new No. 2 Caster be built.

All totalled, future water conservation techniques in the Blast Furnace, Hot Mill and Steelmaking areas could reduce Dofasco's baywater withdrawal by more than 30 billion gallons per year. Finally, by implementing the 4 "R's", a 6% decrease in city water usage plantwide is expected annually over the next 4 years to meet a projected target of 3,600 gallons per minute in 1992.

FIGURE 1

DOFASCO CITY WATER USE
(PLANT TOTAL)

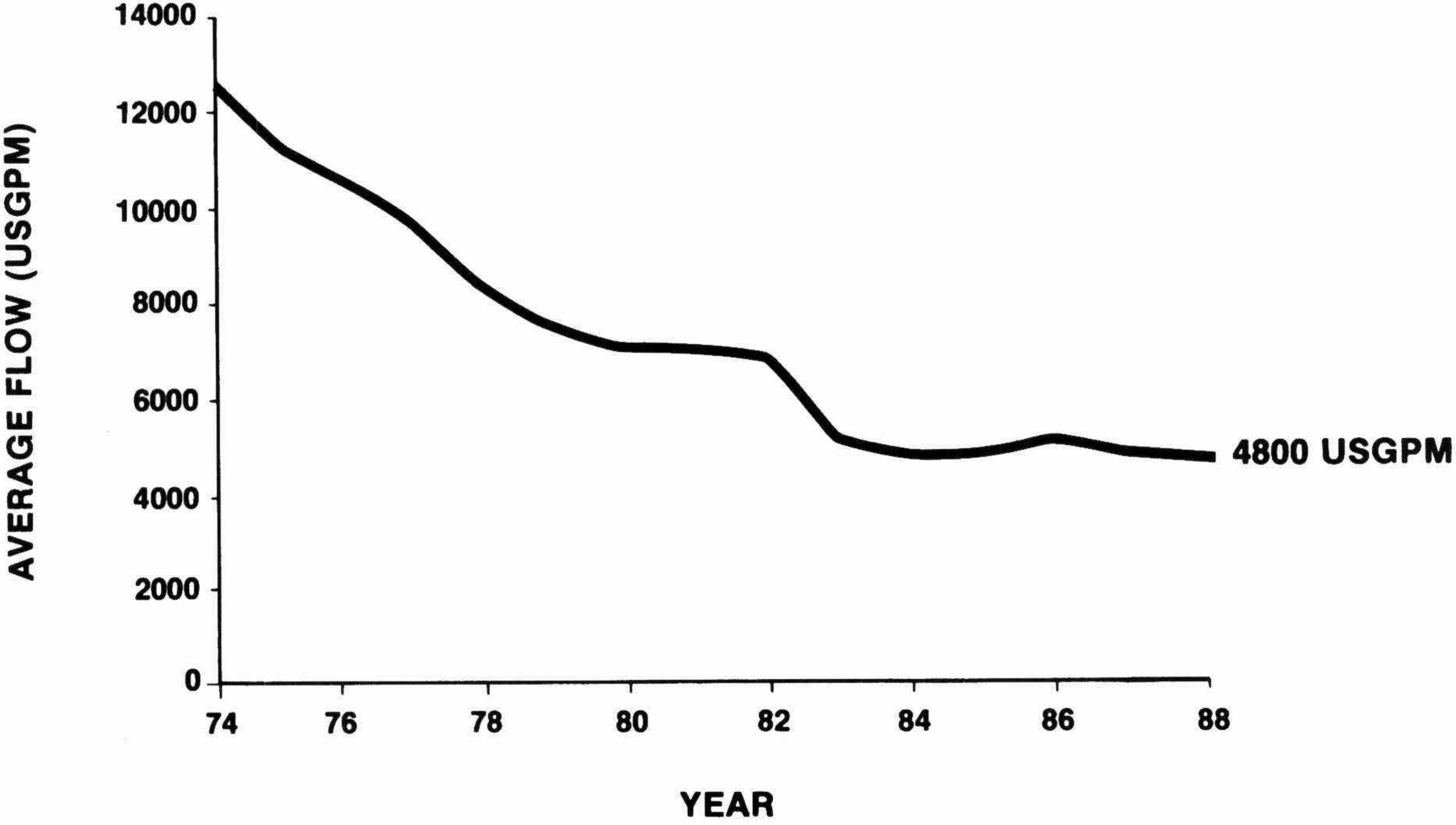
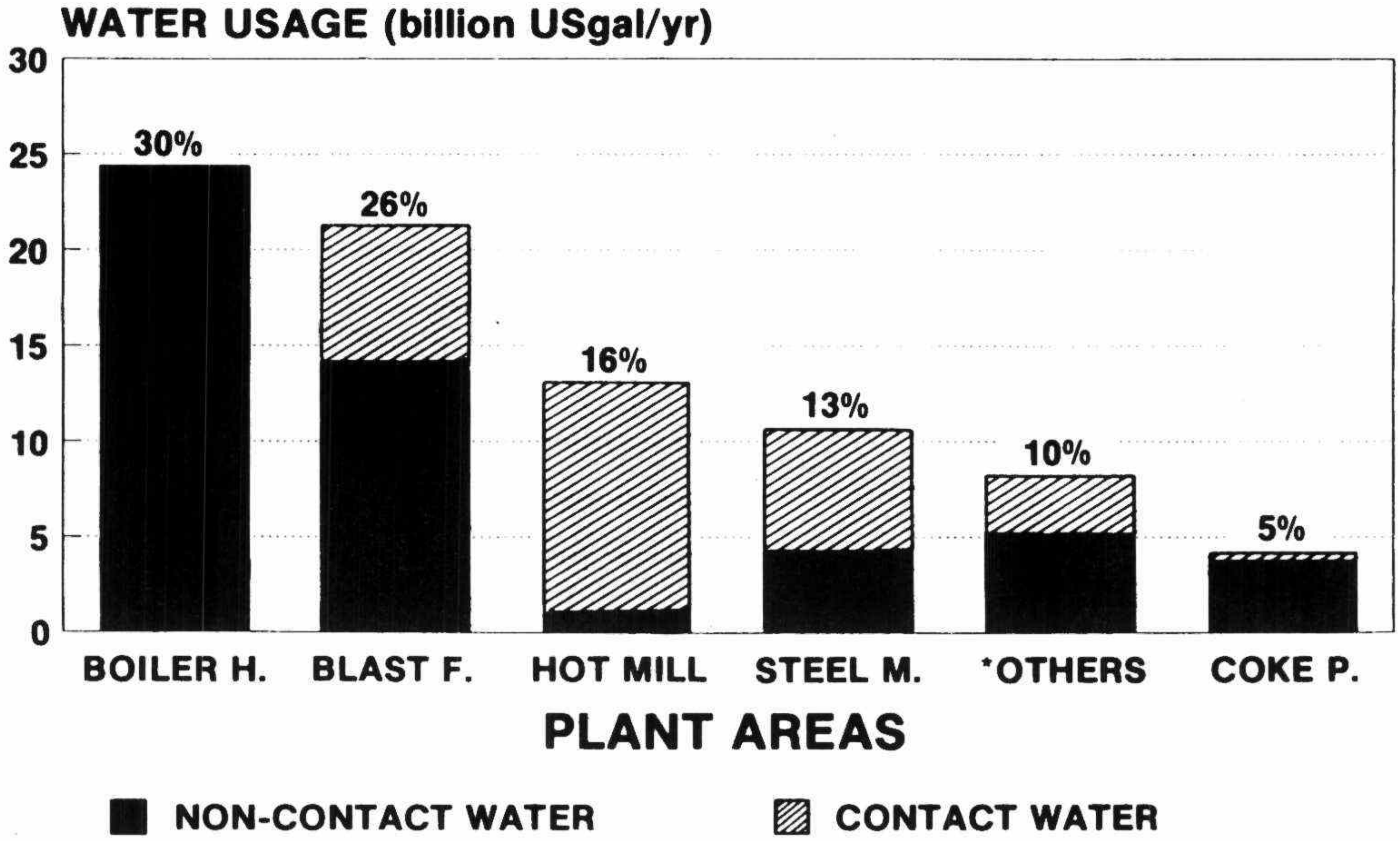


FIGURE 2

WATER USE BY PLANT AREA

(1987/88)



* FOUNDRY, COLD MILL, COATING/FINISHING

FIGURE 3

RESIDUE PARTICULATE DISCHARGES TO HAMILTON HARBOUR

ANNUAL GEOMETRIC MEAN

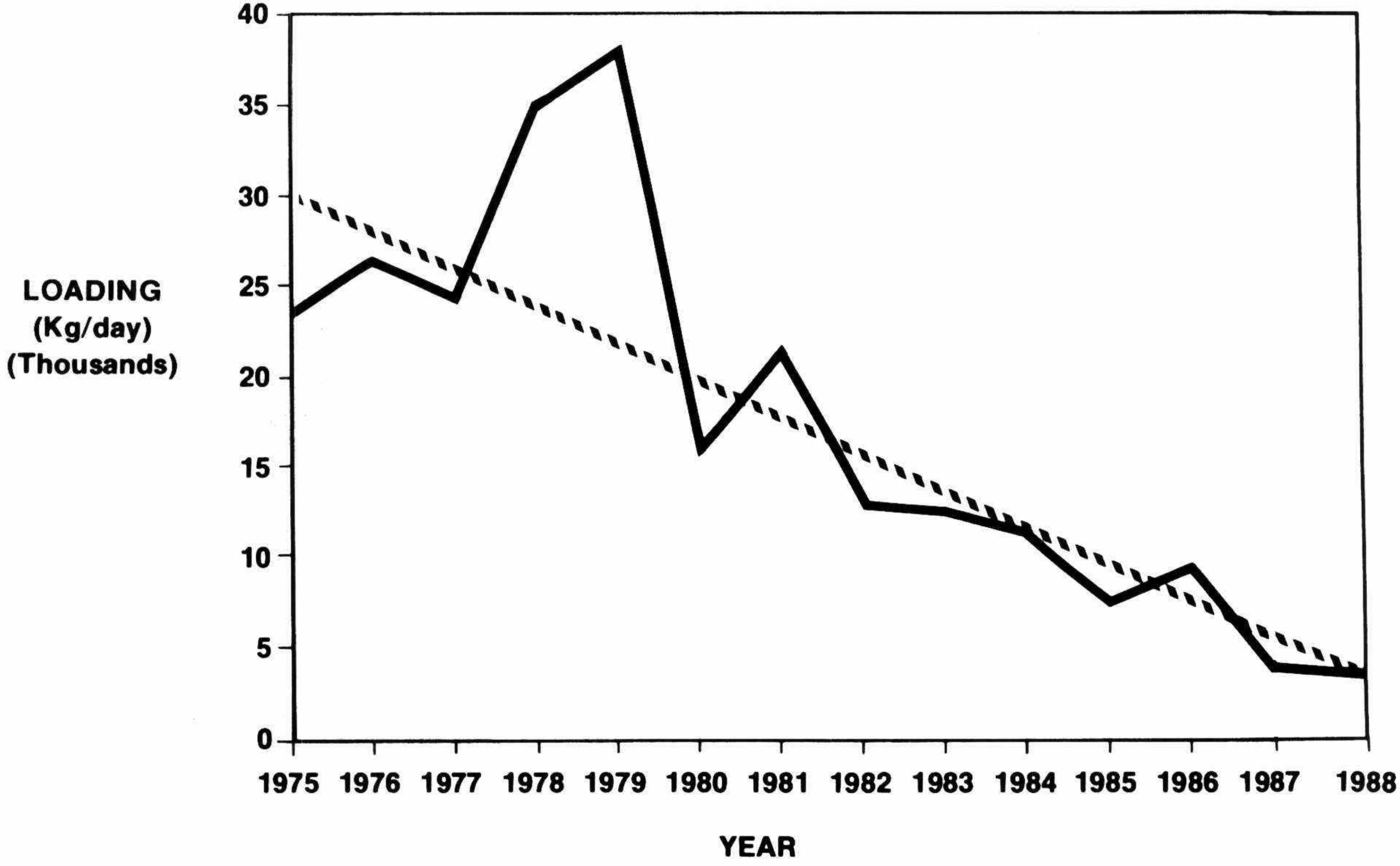


FIGURE 4

AMMONIA-N DISCHARGES TO HAMILTON HARBOUR

ANNUAL GEOMETRIC MEAN

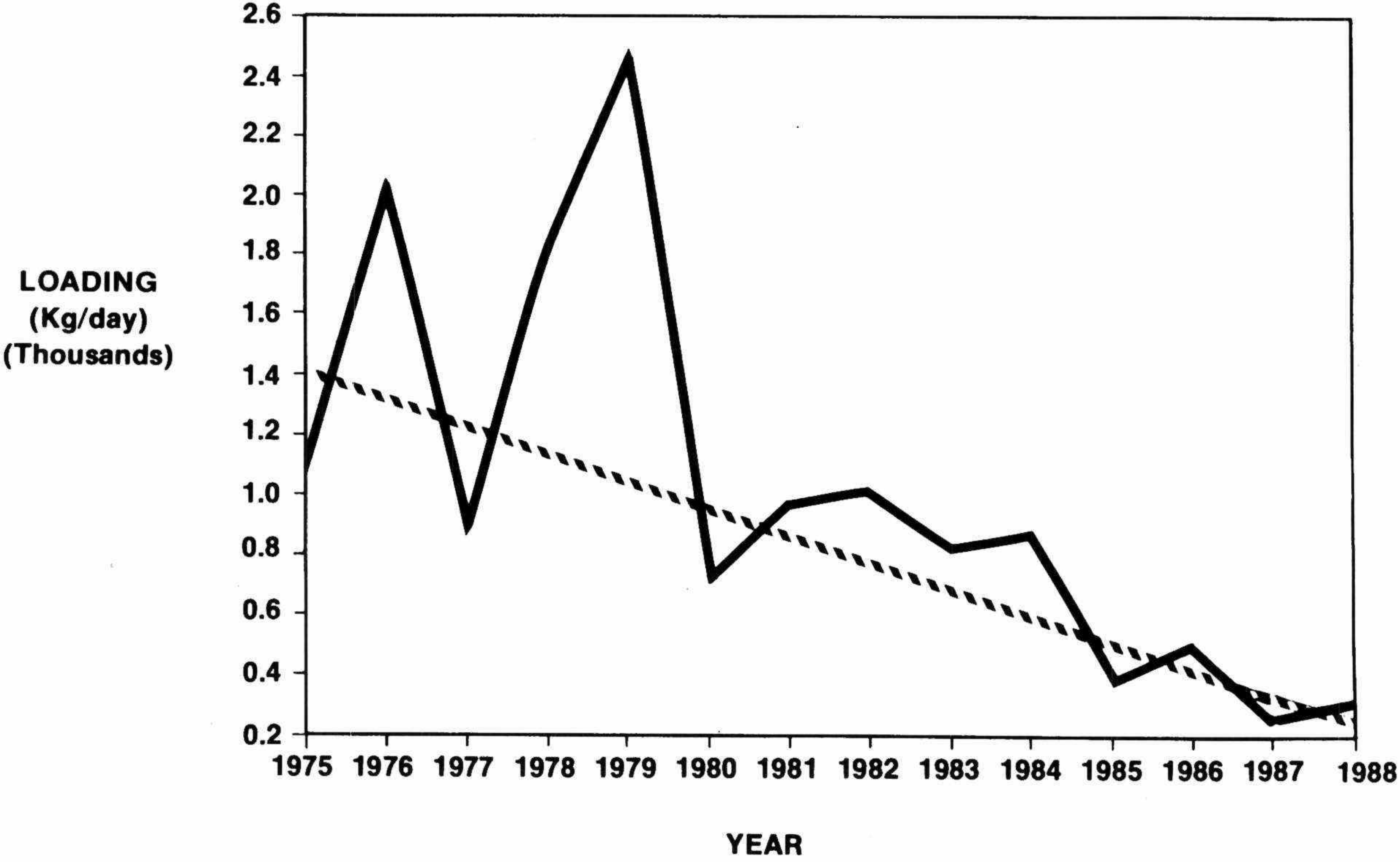


FIGURE 5

INDUCED DRAFT TOWER

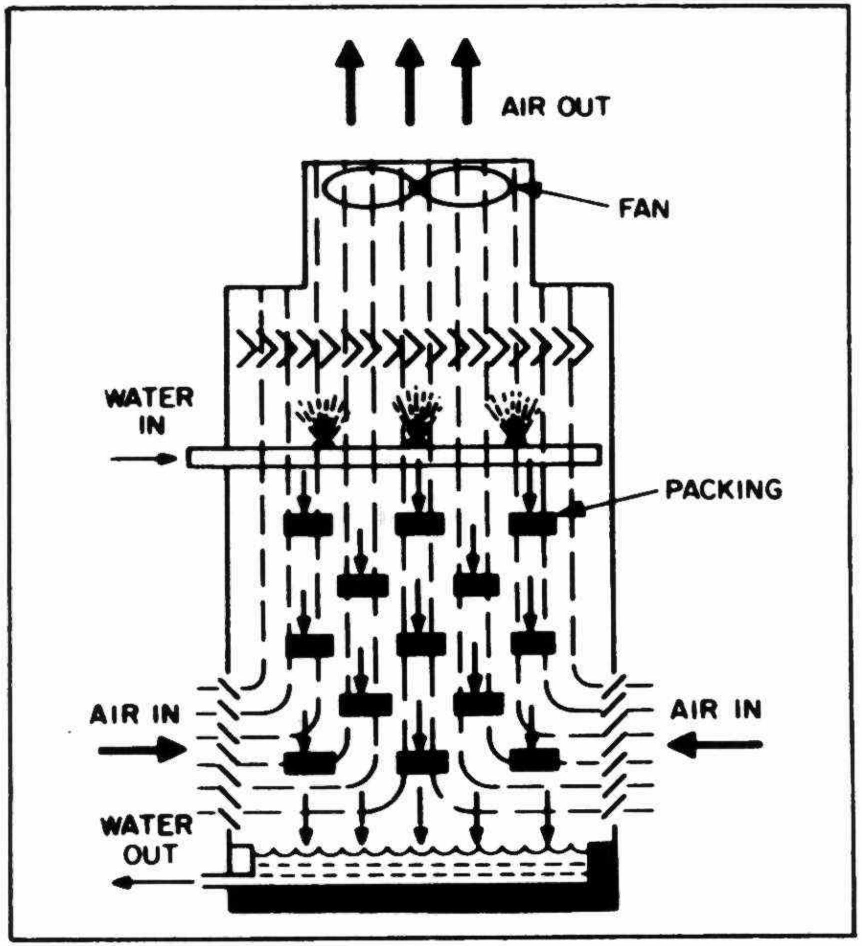


FIGURE 6

NO. 1 AND NO. 2 GALV. LINE RECIRC. COOLING WATER SYSTEM

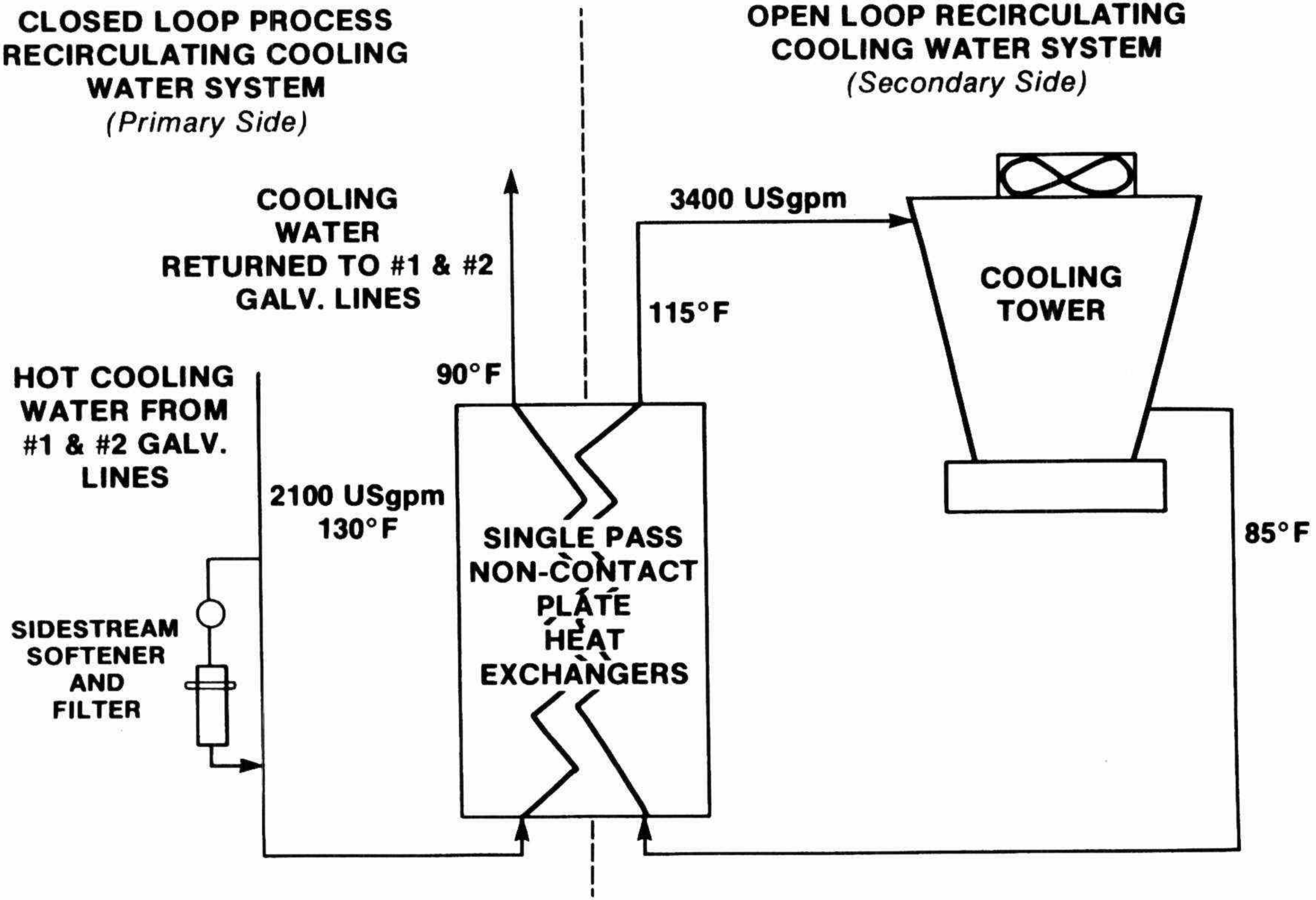

CLOSED LOOP PROCESS RECIRCULATING COOLING WATER SYSTEM
(Primary Side)
OPEN LOOP RECIRCULATING COOLING WATER SYSTEM
(Secondary Side)
COOLING WATER RETURNED TO #1 & #2 GALV. LINES
3400 USgpm
COOLING TOWER
115°F
90°F
HOT COOLING WATER FROM #1 & #2 GALV. LINES
2100 USgpm
130°F
SINGLE PASS NON-CONTACT PLATE HEAT EXCHANGERS
85°F
SIDESTREAM SOFTENER AND FILTER

FIGURE 7

NO. 2 HOT MILL FILTRATION PLANT

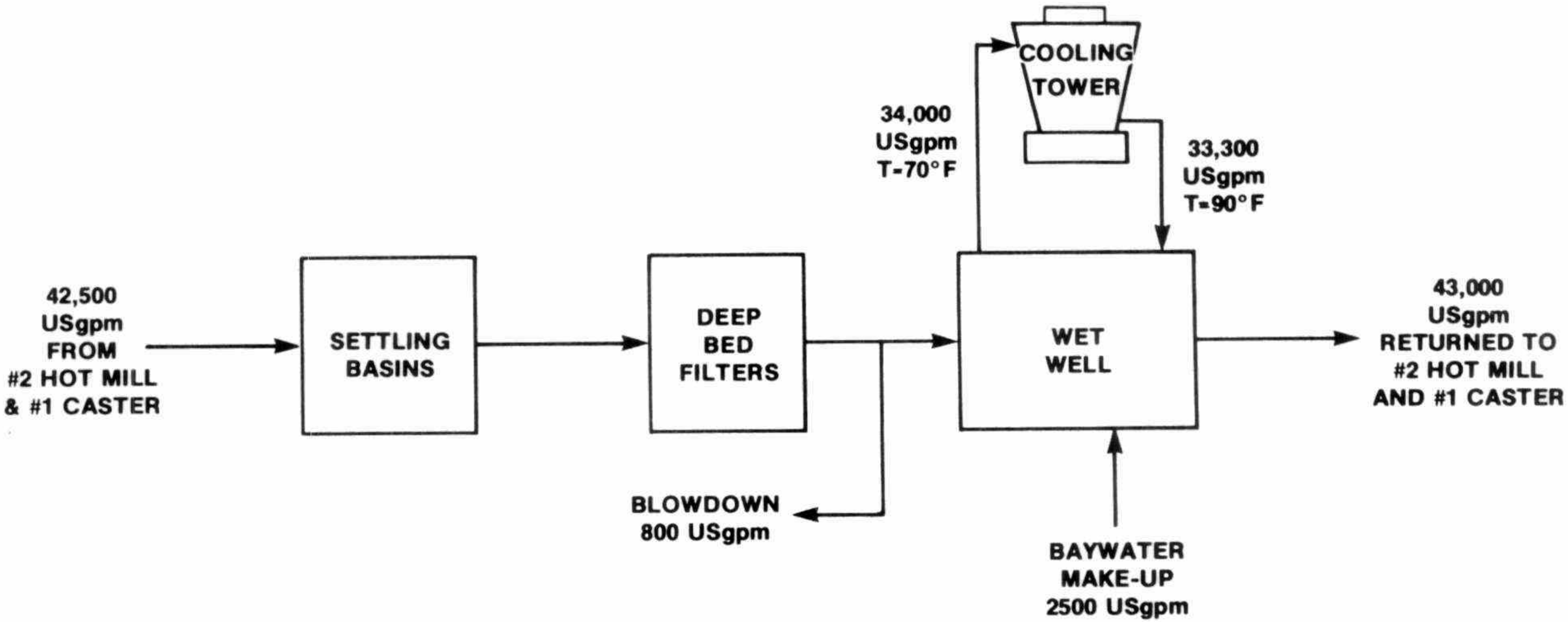

42,500 USgpm FROM #2 HOT MILL & #1 CASTER
SETTLING BASINS
DEEP BED FILTERS
BLOWDOWN 800 USgpm
COOLING TOWER
34,000 USgpm T-70°F
33,300 USgpm T=90°F
WET WELL
BAYWATER MAKE-UP 2500 USgpm
43,000 USgpm RETURNED TO #2 HOT MILL AND #1 CASTER

FIGURE 8

ION EXCHANGE SYSTEM

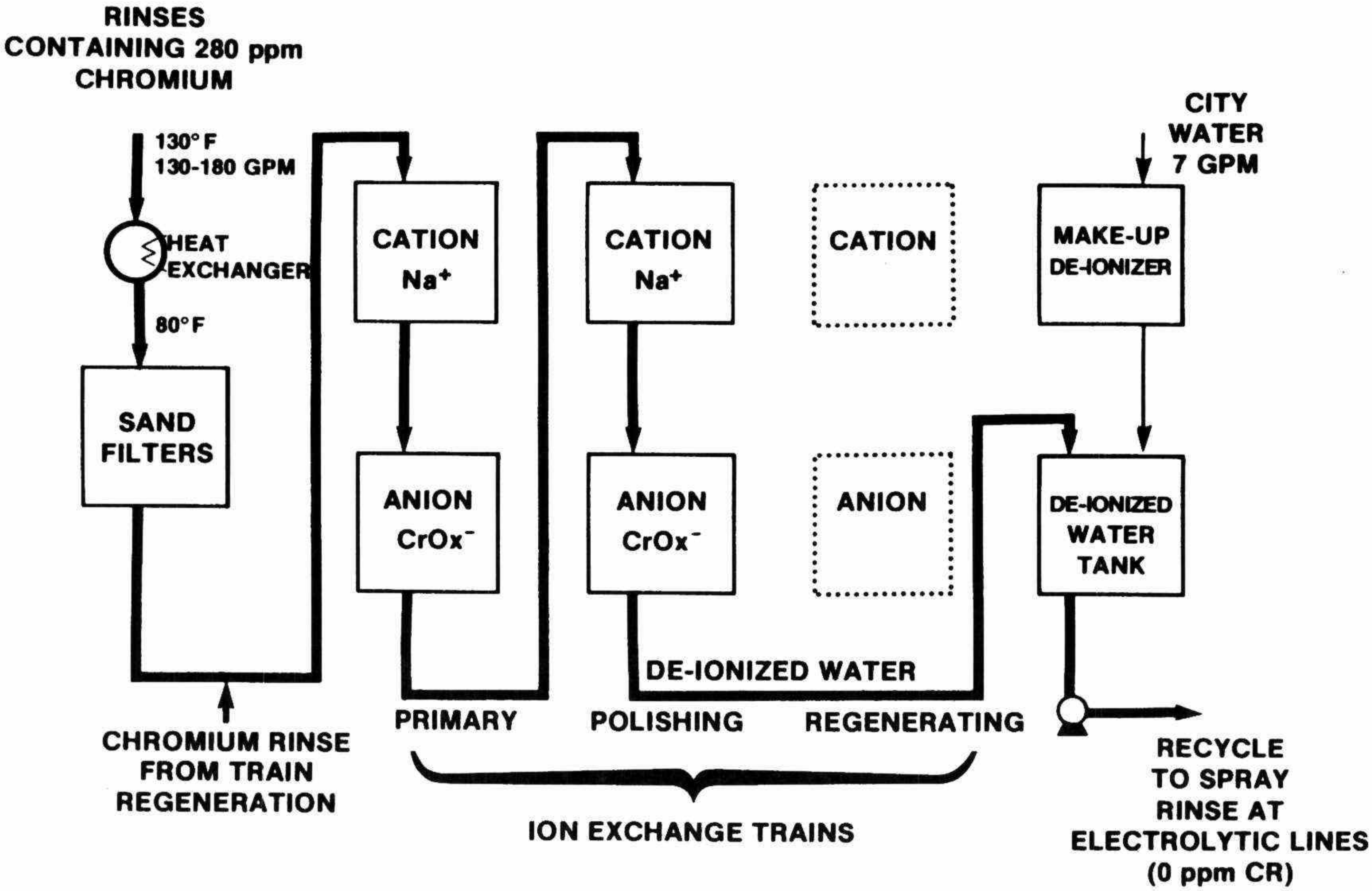


FIGURE 9

BOILERHOUSE OPERATION

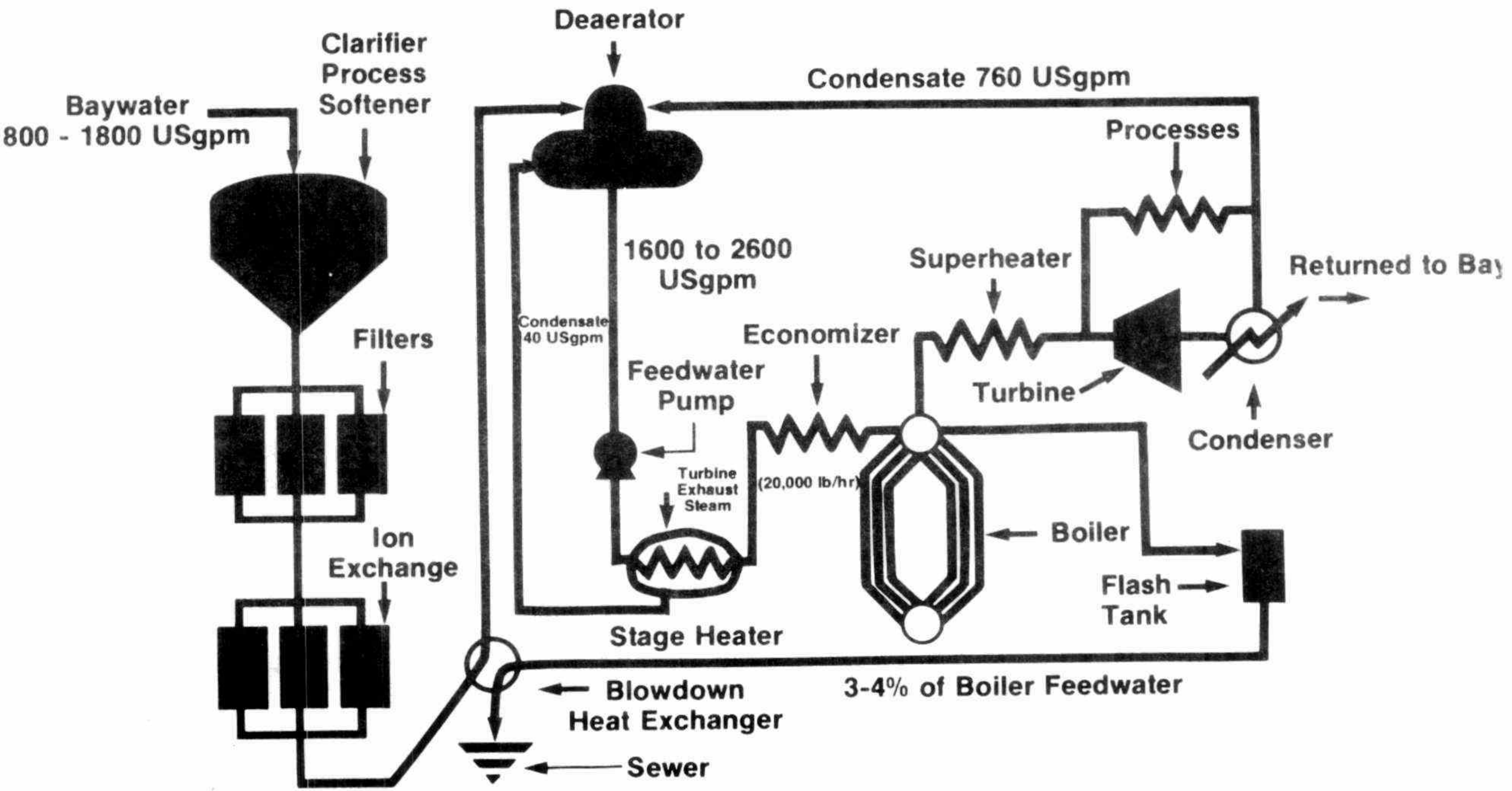


FIGURE 10

NO. 1 MELT SHOP STEAM HOOD SYSTEM

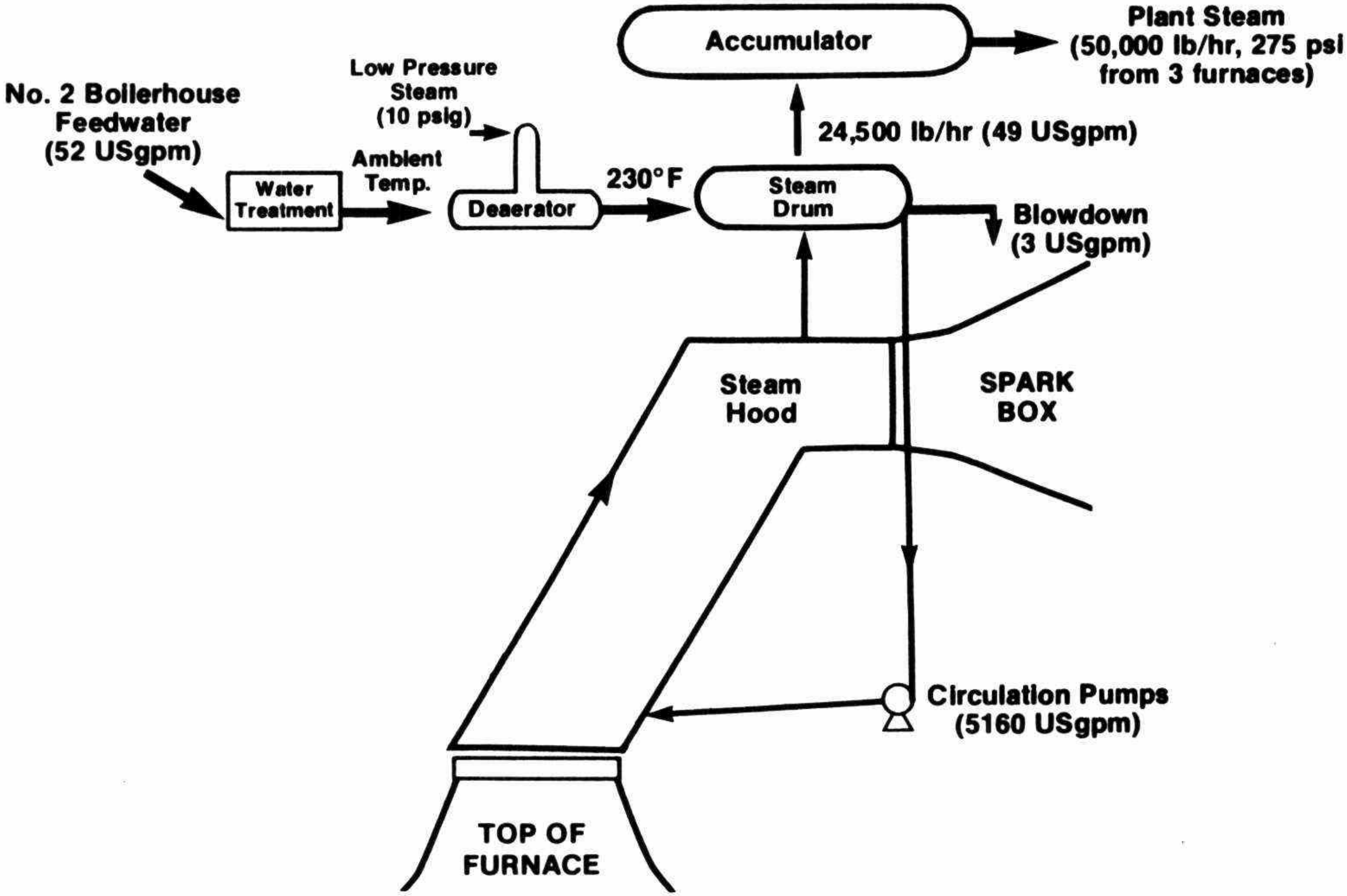


FIGURE 11

REHEAT FURNACE SYSTEM

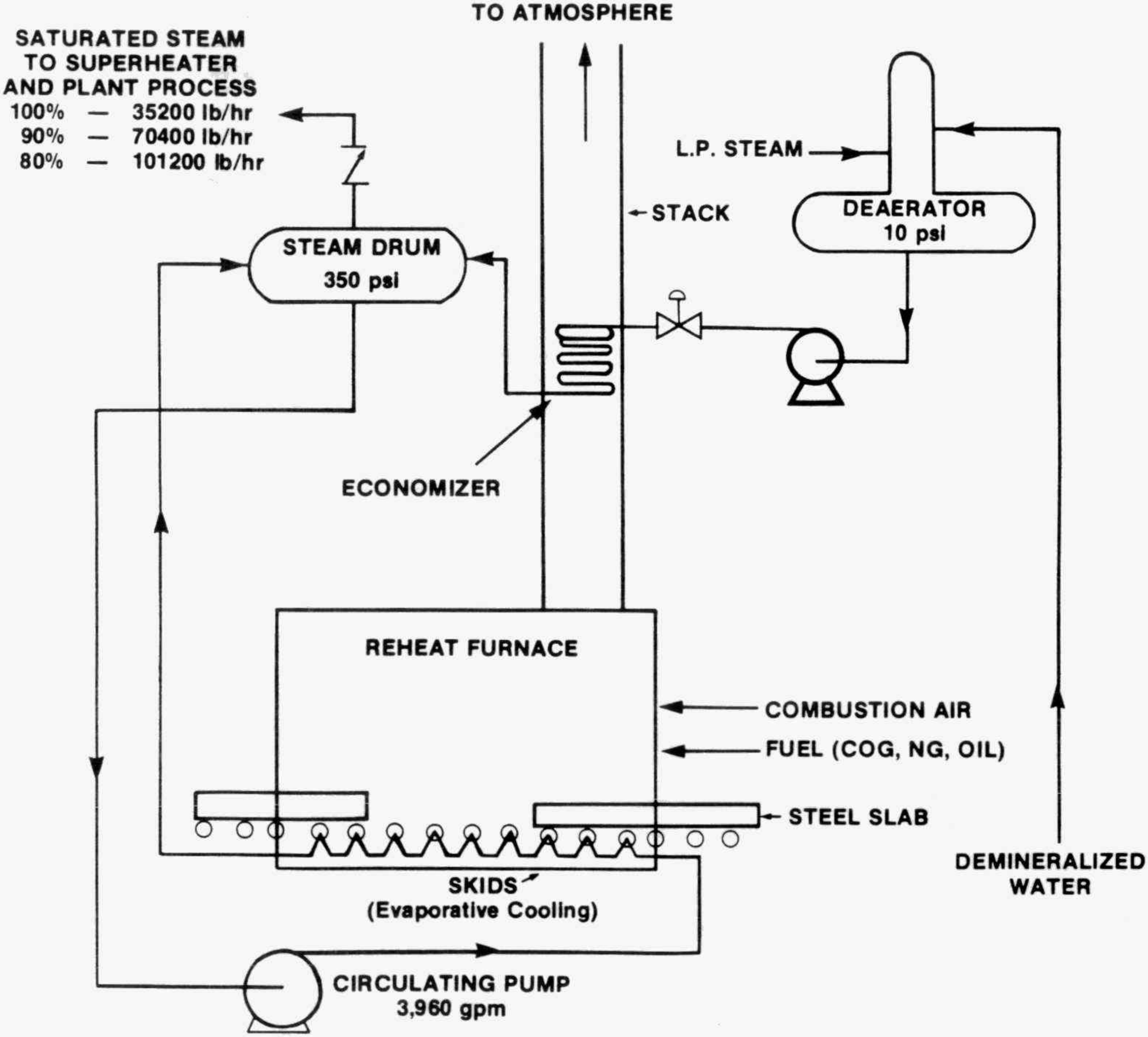


FIGURE 12

WATER REUSE AT NO. 3 COKE PLANT

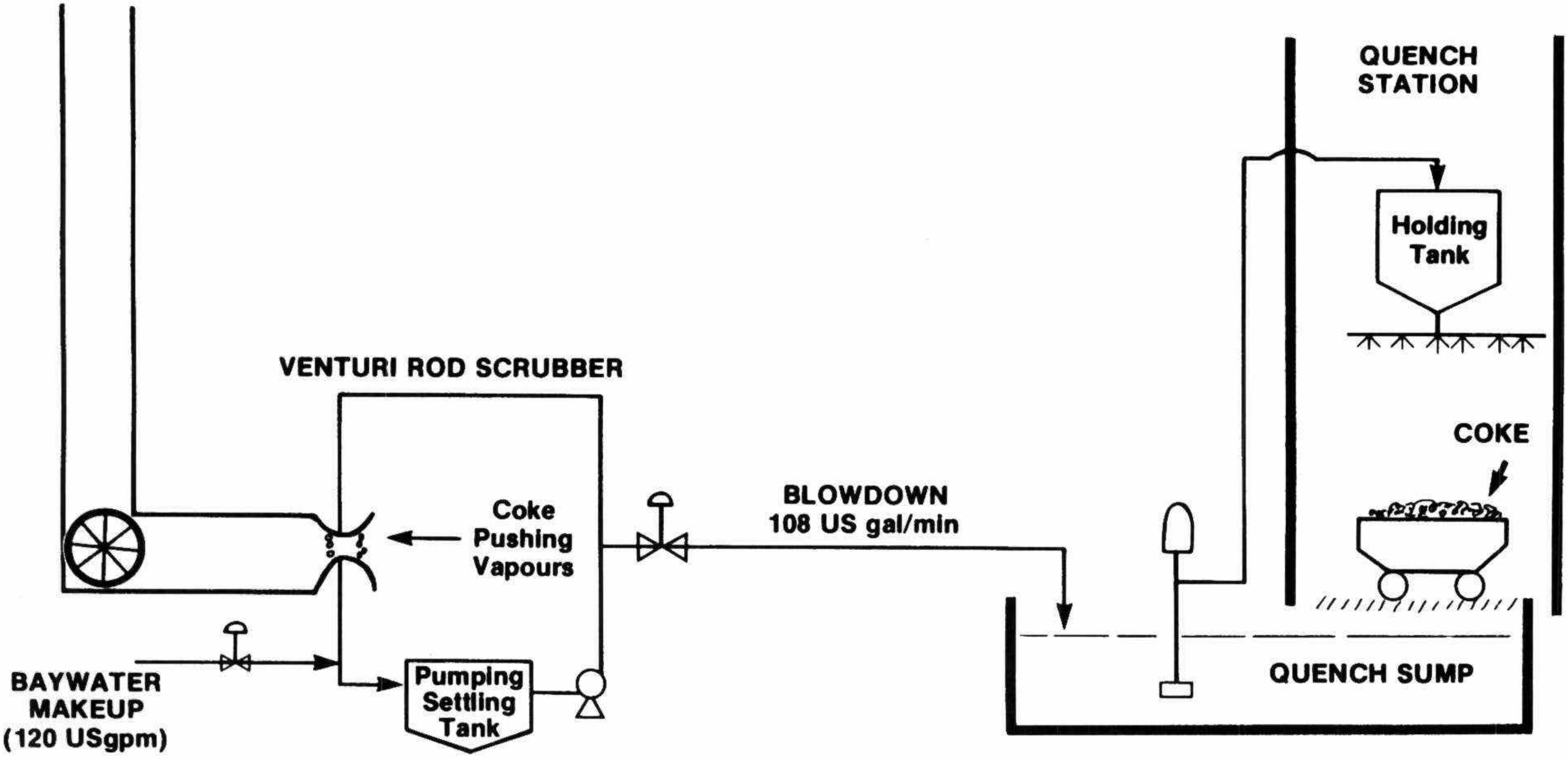


FIGURE 13

WATER REUSE AT HOT MILL DESCALE

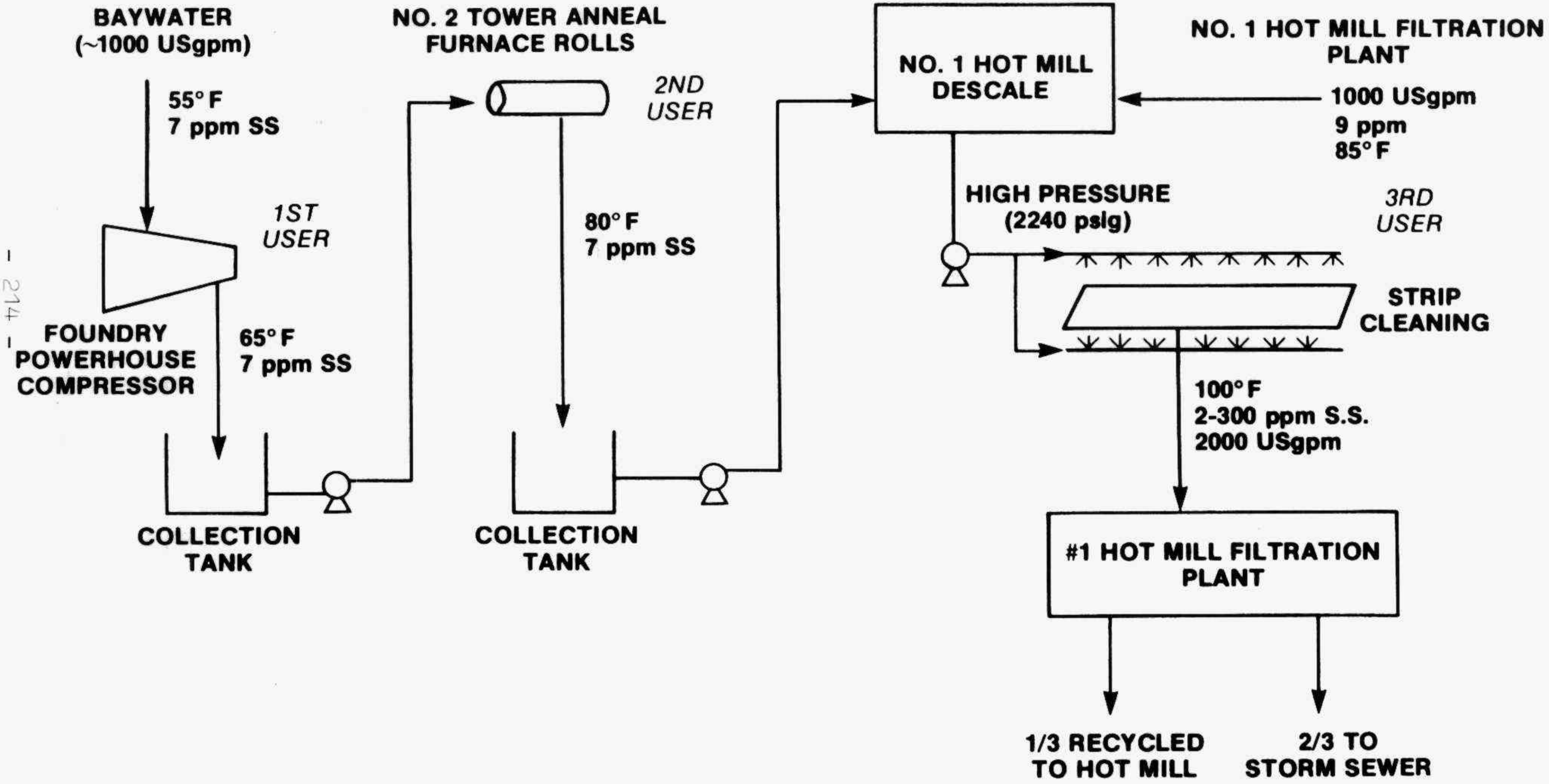


FIGURE 14

COUNTERFLOW RINSING AT ELECTROLYTIC LINES

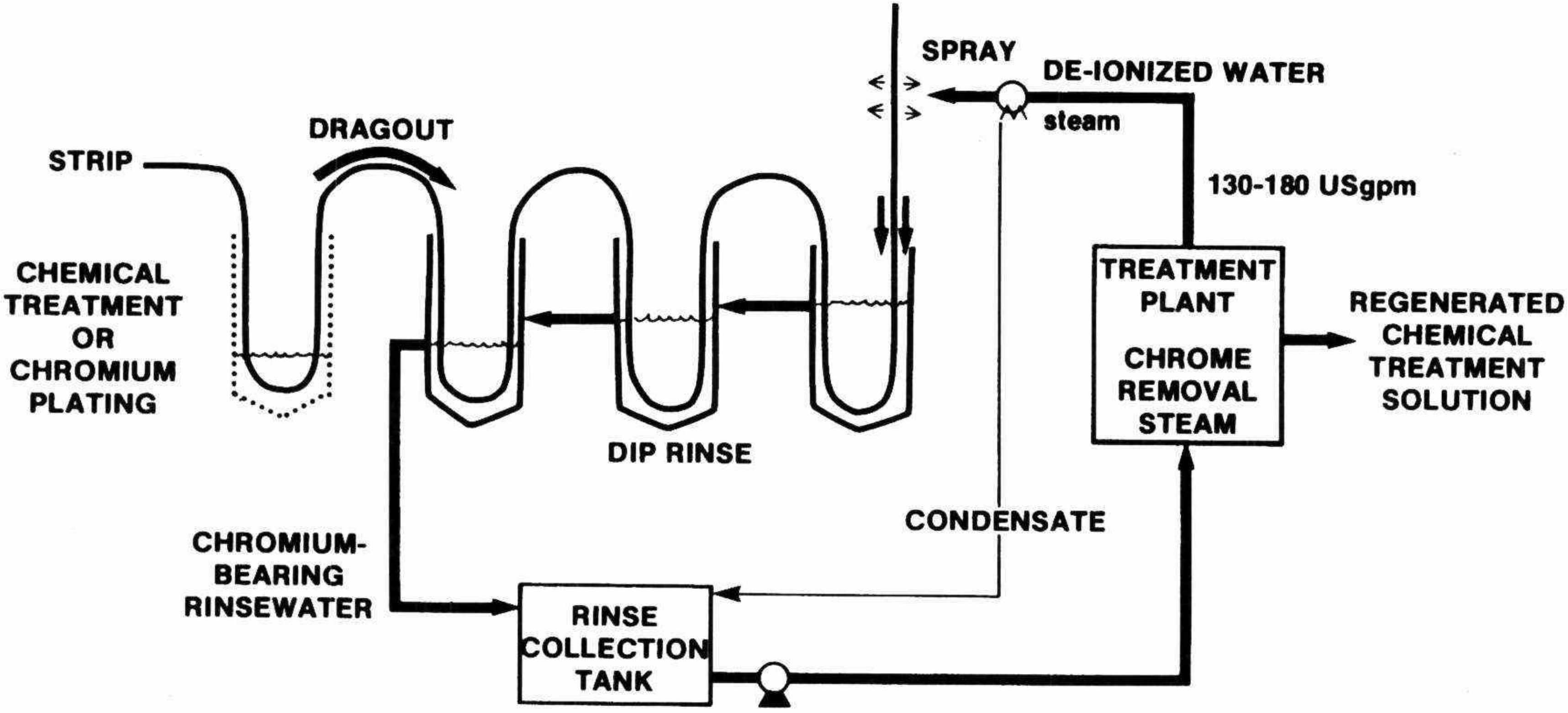
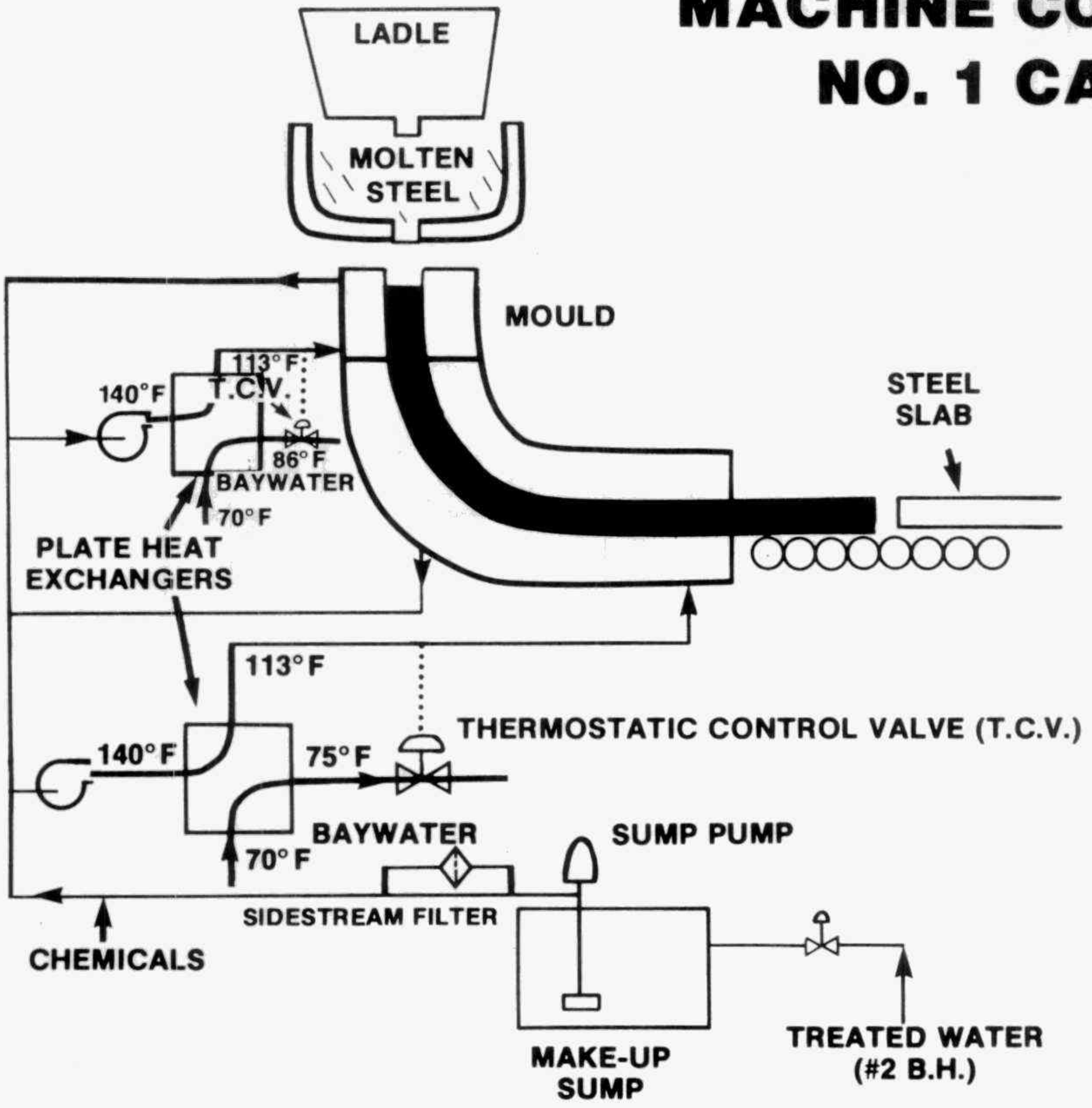


FIGURE 15

USE OF THERMOSTATIC CONTROL FOR MOULD AND MACHINE COOLING AT NO. 1 CASTER



RAYOX - A SECOND GENERATION ENHANCED OXIDATION PROCESS FOR THE DESTRUCTION OF WATERBORNE CONTAMINANTS

by

Dr. S. Stevens, President, Solarchem Environmental
Systems, Richmond Hill, Ontario

INTRODUCTION

The demand for a means of removing small amounts (< 100 mg/l or 100 ppm) of a variety of toxic or persistent waterborne compounds has steadily increased in the past fifteen years. During the latter half of the 1980's the "push" in a number of jurisdictions has been to reduce the concentrations of many of these substances to the low or sub parts per billion (ppb) level.

To meet this demand, a number of approaches (e.g. air stripping, activated carbon, reverse osmosis) have been employed, with varying degrees of success, depending upon the nature of the problem. However, each of the above mentioned techniques has associated with it a secondary disposal problem, in that they do not destroy the waterborne contaminant but merely transfer the problem from one environmental medium to another.

Early attempts to oxidize the waterborne contaminants "in situ" with oxidants such as ozone (O_3), hydrogen peroxide (H_2O_2), hyprochlorous acid (HOCl) or hypochlorite ion (OCl-) have met with limited success because of the excessively long contact times or the prohibitively large amount of oxidant required to achieve the desired degree of decontamination.

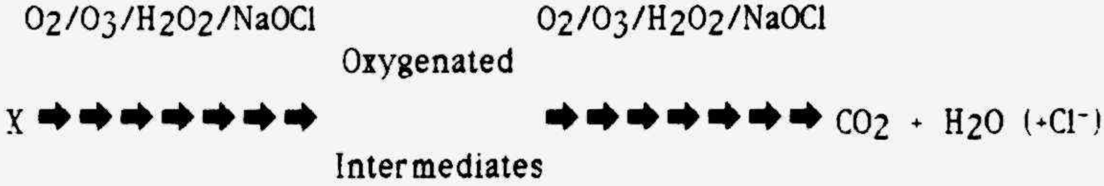
The capability of oxidizing waterborne contaminants "in situ" has improved dramatically during the past ten years, resulting in a major reduction in the contact times required along with a concurrent reduction in the costs involved. This dramatic improvement is the result of the enhanced oxidation process.

THE ENHANCED OXIDATION PROCESS

To help understand enhanced oxidation, it would be useful to begin by defining simple oxidation so that the difference between simple and enhanced oxidation can be more easily explained. For the purposes of this presentation, simple oxidation can be defined as:

> The chemical conversion of a contaminant, by means of a reaction with an oxidant such as O_2, O_3, H_2O_2 or NaOCl, to a benign, more oxidized form, and ultimately to CO_2 and water.

Generalized Reaction:



$$X \xrightarrow{O_2/O_3/H_2O_2/NaOCl} \underset{\text{Intermediates}}{\overset{\text{Oxygenated}}{}} \xrightarrow{O_2/O_3/H_2O_2/NaOCl} CO_2 + H_2O\ (+Cl^-)$$

Where X represents a waterborne contaminant and the multiple arrows are meant to indicate that the conversion is a multi step process. Thermodynamics tells us that virtually any organic contaminant, in the presence of a direct oxidizing source, will, if given enough time, be fully mineralized to CO_2, H_2O, and/or Cl^- (in the case of a chlorinated compound). However, the oxidation rates for such direct processes are typically too slow to be of broad utility for wastewater treatment in the context of today's regulatory environment.

In the mid-seventies, a number of reports appeared describing the enhanced rate of oxidation that was obtained when contaminated water with either dissolved O_3 or H_2O_2 was irradiated with ultraviolet (UV) light. One of the first reports was given by Prengle and co-workers (1). The principles of this synergy are now understood and agreed upon in broad terms by researchers in this field. Recent discussions of this topic are given by Peyton(2), Dore(3) and Hoigne et al (4).

Based upon the findings of the above investigations, a useful definition of enhanced oxidation would be:

A process, where the rate of oxidation of a contaminant is greatly enhanced over that obtained by simple oxidation alone due to the additional participation of powerful oxidizing radical agents such as $HO\bullet$, $HO2\bullet$ and $O\bullet$.

Generalized Reaction:

$$X + HO\bullet \xrightarrow{O_2/H_2O} CO_2 + H_2O\ (+Cl^-)$$

Once generated, the $HO\bullet$ radicals aggressively react with any oxidizable contaminant in solution. An overview of the comparative rate of $HO\bullet$ attack on various classes of contaminants compared to that for O_3 is given in Table 1. A review of the data in Table 1 shows that the rate of $HO\bullet$ attack on contaminants is typically 10^6 to 10^9 times as fast as the rate of $O3$ attack.

The $HO\bullet$ radical reacts with contaminants principally in one of two ways: it can add to the contaminants such as olefins or aromatic compounds or it can abstract a hydrogen atom as with alkanes or alcohols. Either of these processes initiates a complex oxidative cascade of reactions which leads ultimately to CO_2 and H_2O, (and Cl^- in the case of chlorinated compounds).

Solarchem's **Rayox** process can be described as a 2nd generation enhanced oxidation system; that is the rate and range of contaminant destruction is greatly enhanced over that obtained with earlier embodiments of the technology.

For example, **Rayox** can destroy refractory waterborne contaminants such as carbon tetrachloride or fixed cyanides, both of which are impractical to treat with other enhanced oxidative techniques.

In addition, **Rayox** can provide "deep cleaning" such as five or more orders of magnitude of decontamination (>99.999 % destruction) at reasonable cost.

Table 1

REACTION RATES OF OZONE AND HYDROXYL RADICALS WITH CLASSES OF ORGANIC COMPOUNDS (5)

	k, in L $mole^{-1}$ s^{-1}	
COMPOUND	O_3	OH
Olefins	1 to 450×10^3	10^9 to 10^{11}
S-containing organics	10 to 1.6×10^3	10^9 to 10^{10}
Phenols	10^3	10^9
N-containing organics	10 to 10^2	10^8 to 10^{10}
Aromatics	1 to 10^2	10^8 to 10^{10}
Acetylenes	50	10^8 to 10^9
Aldehydes	10	10^9
Ketones	1	10^9 to 10^{10}
Alcohols	10^{-2} to 1	10^8 to 10^9
Alkanes	10^{-2}	10^6 to 10^9
Carboxylic acids	10^{-3} to 10^{-2}	10^7 to 10^9

REASONS FOR **RAYOX'S** SUPERIOR PERFORMANCE

The reasons for **Rayox's** vastly superior performance are principally as follows:

1. Proprietary Reactor Design

Rayox's reactor design incorporates a number of unique features which result in an improved mass and radiation transfer.

2. The Solarchem Lamp

With the Solarchem Lamp not only are extra high intensities attained, but the emission occurs where the contaminant is photochemically active.

3. The ENOX Additives

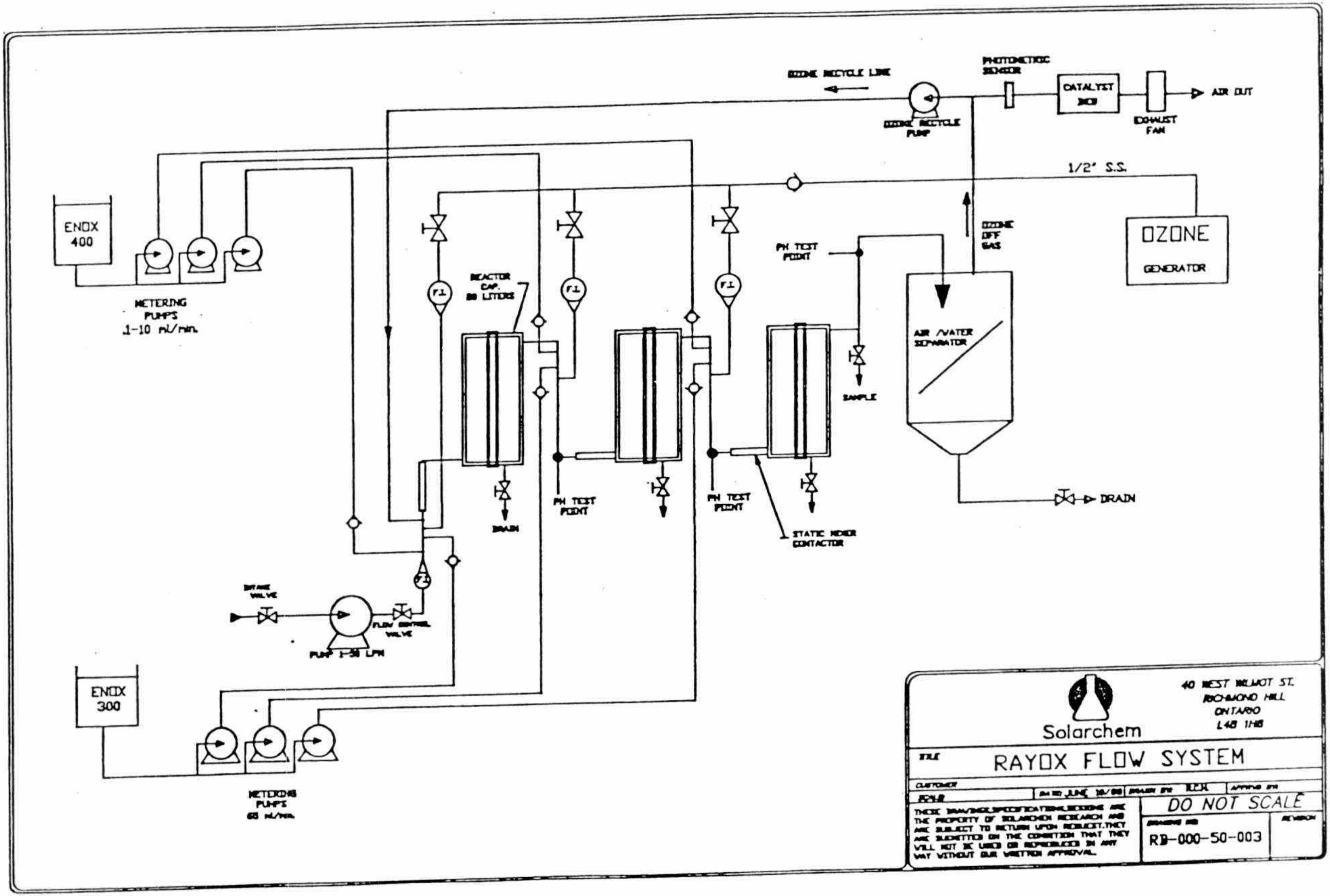
Solarchem has developed a series of consumable additives ("catalysts") which can greatly enhance the efficiency of the radical generation and utilization process.

FLOW SCHEMATIC

A process flow schematic for a typical installed system is shown in Figure1. This unit is designed to run in either continuous or batch mode. Important features of the typical unit include:

- annular 20 litre UVreactors
- capacity for O_3 injection into water stream prior to each reactor
- capacity for ENOX addition into water stream prior to each reactor
- capacity for O_3 recycle
- residual O_3 destruct catalyst for off-gas
- capacity for varying power lamps in the reactors
- capacity to draw samples at several points
- automatic pH control
- system controller (PLC)

Figure 1


OZONE RECYCLE LINE
OZONE RECYCLE PUMP
PHOTOMETRIC SENSOR
CATALYST BED
EXHAUST FAN
AIR OUT
1/2' S.S.
OZONE OFF GAS
OZONE GENERATOR
PH TEST POINT
ENOX 400
METERING PUMPS .1-10 ml/min.
REACTOR CAP. 80 LITERS
F.I.
F.I.
F.I.
AIR /WATER SEPARATOR
SAMPLE
DRAIN
PH TEST POINT
PH TEST POINT
STATIC MIXER CONTACTOR
DRAIN
F.I.
INTAKE VALVE
FLOW CONTROL VALVE
PUMP 1-50 LPM
ENOX 300
METERING PUMPS 65 ml/min.
Solarchem
40 WEST WILMOT ST.
RICHMOND HILL
ONTARIO
L4B 1H8
TITLE
RAYOX FLOW SYSTEM
CUSTOMER
SCALE
DATE JUNE 10/88
DRAWN BY R.C.H.
APPROVED BY
THESE DRAWINGS,SPECIFICATIONS,DESIGNS ARE THE PROPERTY OF SOLARCHEM RESEARCH AND ARE SUBJECT TO RETURN UPON REQUEST.THEY ARE SUBMITTED ON THE CONDITION THAT THEY WILL NOT BE USED OR REPRODUCED IN ANY WAY WITHOUT OUR WRITTEN APPROVAL.
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DRAWING NO
RB-000-50-003
REVISION

The optimum process configuration used will vary from one type of waste stream to another. For example, the optimum configuration for treating the process water from a wood treating plant will be significantly different from the optimum design for eliminating chlorinated solvents from groundwater.

COST FACTORS

The cost and design considerations for a second generation enhanced oxidation system like **Rayox** will depend on four major considerations:

- the nature of the contaminant - affects the choice of oxidant and ENOX as well as the type of UV light required
- the initial concentration - affects the amount of oxidant and ENOX required, as well as the processing time
- the flow rate - affects the number, size and design of the reactors, as well as the lamp power to be used
- the degree of removal required - affects the processing time, the number and nature of the treatment stages, as well as the reactor design

It is normally advisable to optimize the process configuration in a treatability study before on-site field work begins

DISCUSSION OF EXAMPLES

The data and discussion which follow provide results obtained with actual customer provided contaminated water before final system design began.

Analytical measurements were made using standard methods on HPLC, GC-ECD, GC-FID, GC-PID or GC-MS depending upon the nature of the analysis being carried out.

PHENOL & PENTACHLOROPHENOL

Phenol is a widely used chemical and consequently appears frequently in wastewater streams. Pentachlorophenol (PCP) is a bacteridicide still fairly widely used as a wood preservative, usually for telephone poles. The Ontario Ministry of the Environment currently requires that discharges into surface waterbodies or storm sewers have less than 15µg/l (15 ppb) of phenol, and less than 10µg/l (10 ppb) of pentachlorophenol.

In a system designed for an Ontario wood treating industry customer, the **Rayox** unit is used to decontaminate the process water from a PCP/creosote plant before discharge into a nearby recreational river. The **Rayox** unit achieves greater than 99.99% destruction of the phenol and PCP in the process wastewater which also contains other contaminants such as oil and grease. Figure 2 shows the results obtained for the destruction of phenol and pentachlorophenol in the wood treatment plant process water. From Figure 2 it can be seen that the required degree of contaminant destruction is easily met.

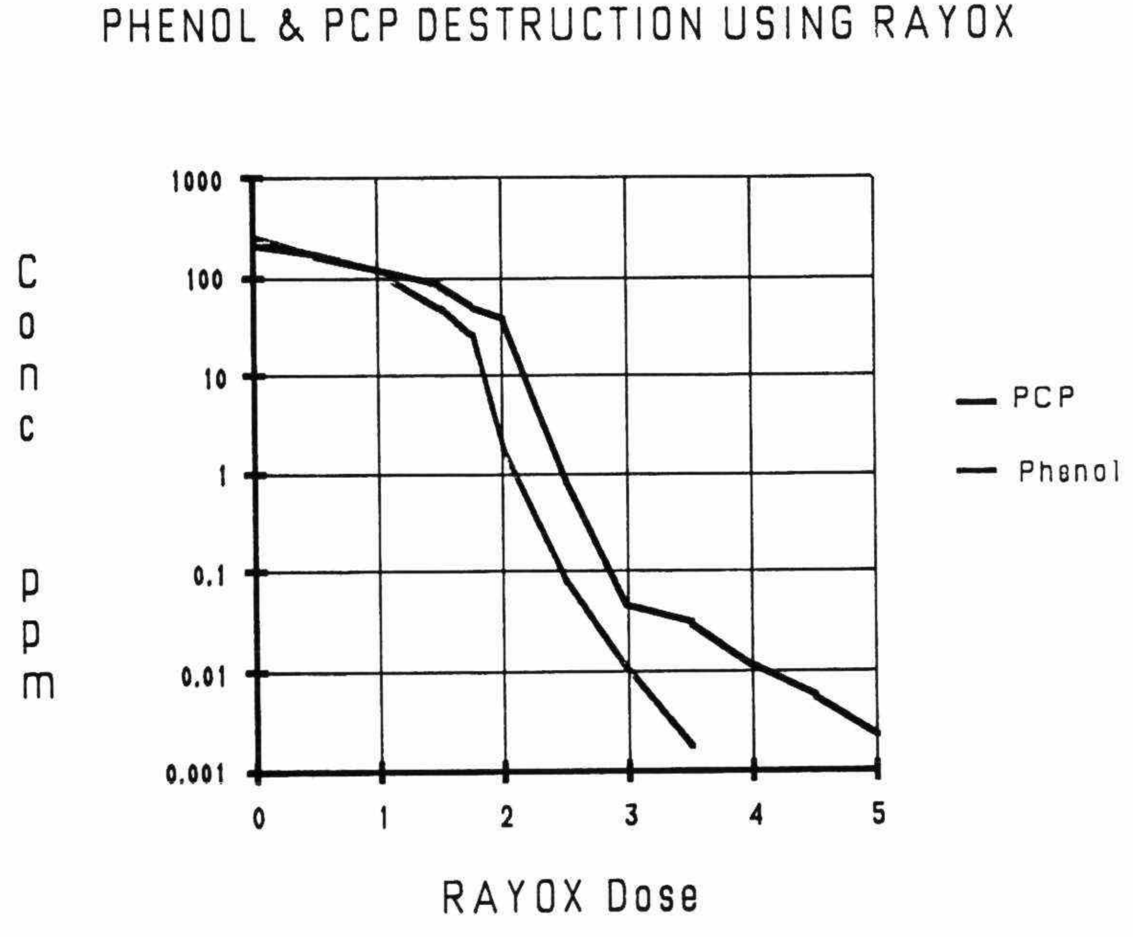
It is also noteworthy that the dioxin and furan concentrations in this stream were similtaneously reduced to 1.5 ng/l (1.5 ppt) or less. The concentration of the 2, 3, 7, 8 isomer was reduced to less than 0.23 ng/l (0.23 ppt) from an influent design specification of 60 ppb.

DIHYDROXYBENZENES

Dihydroxybenzenes are fairly widely used specialty chemicals in the photographic, tire, rubber and adhesives industries and thus are often found in the wastewater from these operations.

Because of their toxicity to aquatic life, they are often treated like phenol in a regulatory sense, i.e. concentrations of less than 15 µg/l (15 ppb) in water discharges to surface water bodies, or < 1 mg/l (1 ppm) to sanitary sewers (POTWs).

Figure 2


PHENOL & PCP DESTRUCTION USING RAYOX
Conc ppm
1000
100
10
1
0.1
0.01
0.001
0
1
2
3
4
5
RAYOX Dose
PCP
Phenol

In a design completed for a majar tire manufacturer, process wastewater containing 800 mg/l (800 ppm) resorcinol (1,3-dihydroxybenzene) along with several other contaminants including high levels of suspended solids are shown in Figure 3. In this stream, **Rayox** removes more than 99.999% of the resorcinol. From these data, it is clear that the surface water discharge regulation as well as that for POTWs can easily be met.

EXPLOSIVE COMPOUNDS

The manufacture of explosives invariably results in the presence of small concentrations of various explosive compounds in process wastewater. Manufacturers have traditionally utilized activated carbon to remove the offending substances in order to meet regulatory requirements.

A number of manufacturers are now seeking alternatives to using carbon, principally for two reasons: the safety issue surrounding the explosive nature of carbon saturated with explosives and the relatively fast breakthrough of other aqua toxic compounds through the carbon bed. (6)

In Figure 4, the results of **Rayox** on site processing of a wastewater stream with an initial TNT concentration of about 100 mg/l (100ppm) are shown. The regulatory requirement in this case was to reduce the TNT concentration in the effluent to less than 1 mg/l (1ppm). From the data in Figure 4 it is clear that this was easily achieved with the **Rayox** system. Furthermore, the treated process water easily passed the LC_{20} biological toxicity test. Given the likelihood of even more stringent regulatory requirements, this customer was pleased to know that decontamination to less than 1 µg/l (1ppb) was straightforwardly achievable in the future, with no increase in capital investment required..

Figure 3

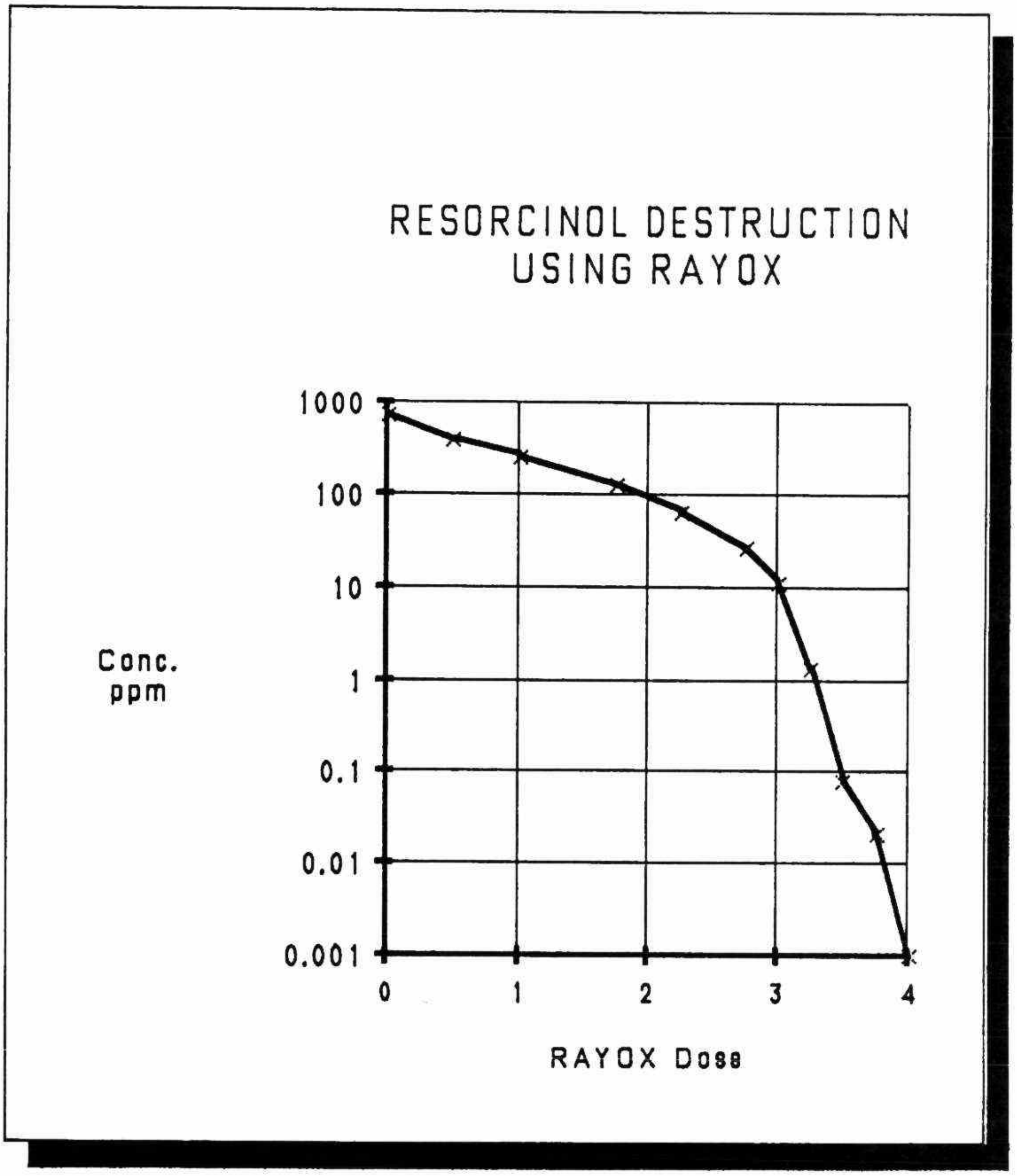
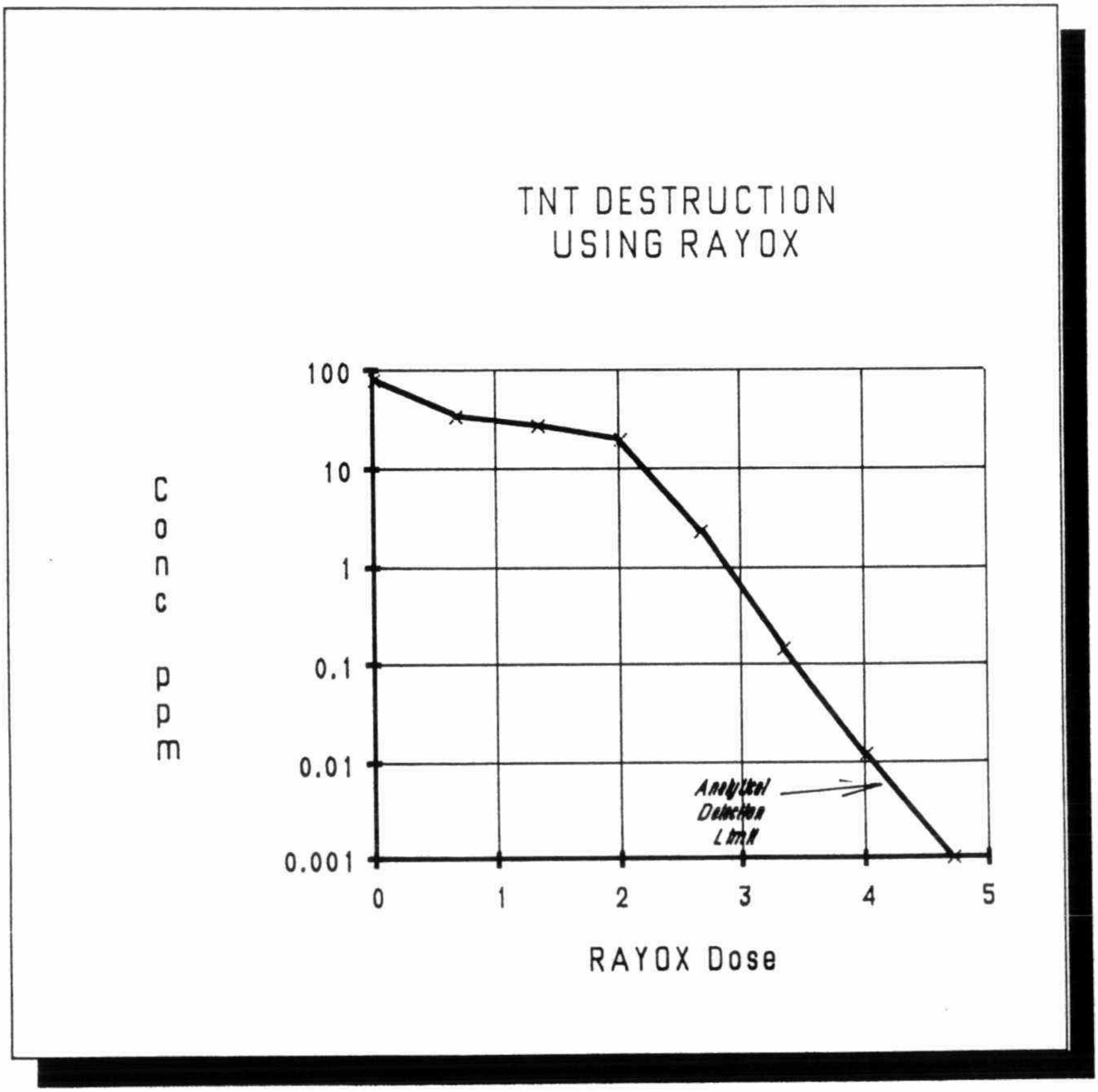

RESORCINOL DESTRUCTION USING RAYOX
1000
100
10
1
0.1
0.01
0.001
Conc. ppm
0
1
2
3
4
RAYOX Dose

Figure 4


TNT DESTRUCTION
USING RAYOX
Conc ppm
100
10
1
0.1
0.01
0.001
0
1
2
3
4
5
RAYOX Dose
Analytical Detection Limit

1,4 DIOXANE

A more refractory compound, and one that is encountered in both groundwater and wastewater streams is 1,4 dioxane or its derivatives.

Figure 5 shows the results of design testing undertaken on the effluent of a biological treatment unit of a chemical plant. In this case the initial dioxane concentration was about 15 mg/l (15 ppm) and had to be reduced to less than 10 μg/l (10 ppb). More than 99.9% contaminant destruction had to be, and was, readily achieved. As can be inferred from Figure 5, even deeper cleaning is possible by simply increasing the **Rayox** dose.

This "deep cleaning" capability of **Rayox** has been confirmed in recent design work carried out on two other groundwater streams contaminated by dioxane. In both cases, the system design specification calls for the dioxane concentration to be reduced to below detection < 1 μg/l (or< 1 ppb), a straightforward task for the **Rayox** system.

BLEACH PLANT EFFLUENT

Increased concern about possible adverse effects of chlorinated organic compounds (AOX or Adsorbable Organic Halides) in the bleach plant effluent of pulp and paper mills has resulted in increasingly stringent discharge regulations. For example, the Ontario Ministry of the Environment has recently announced its intention to reduce the permissible amount of AOX discharged to 2.5 kg per air dried tonne of bleached pulp produced. Other jurisdictions in Canada and the US have also made, or are about to make, similar moves in the near term.

Some preliminary results from a treatability study recently completed on bleach plant effluent are shown in Figure 6. The different lines are the results for different process configurations. For this particular mill, the AOX concentration would have to be reduced to approximately 12 mg/l to meet the proposed new regulation, and from the data it is clear that this target can easily be met. Preliminary cost calculations suggest that this may well

Figure 5

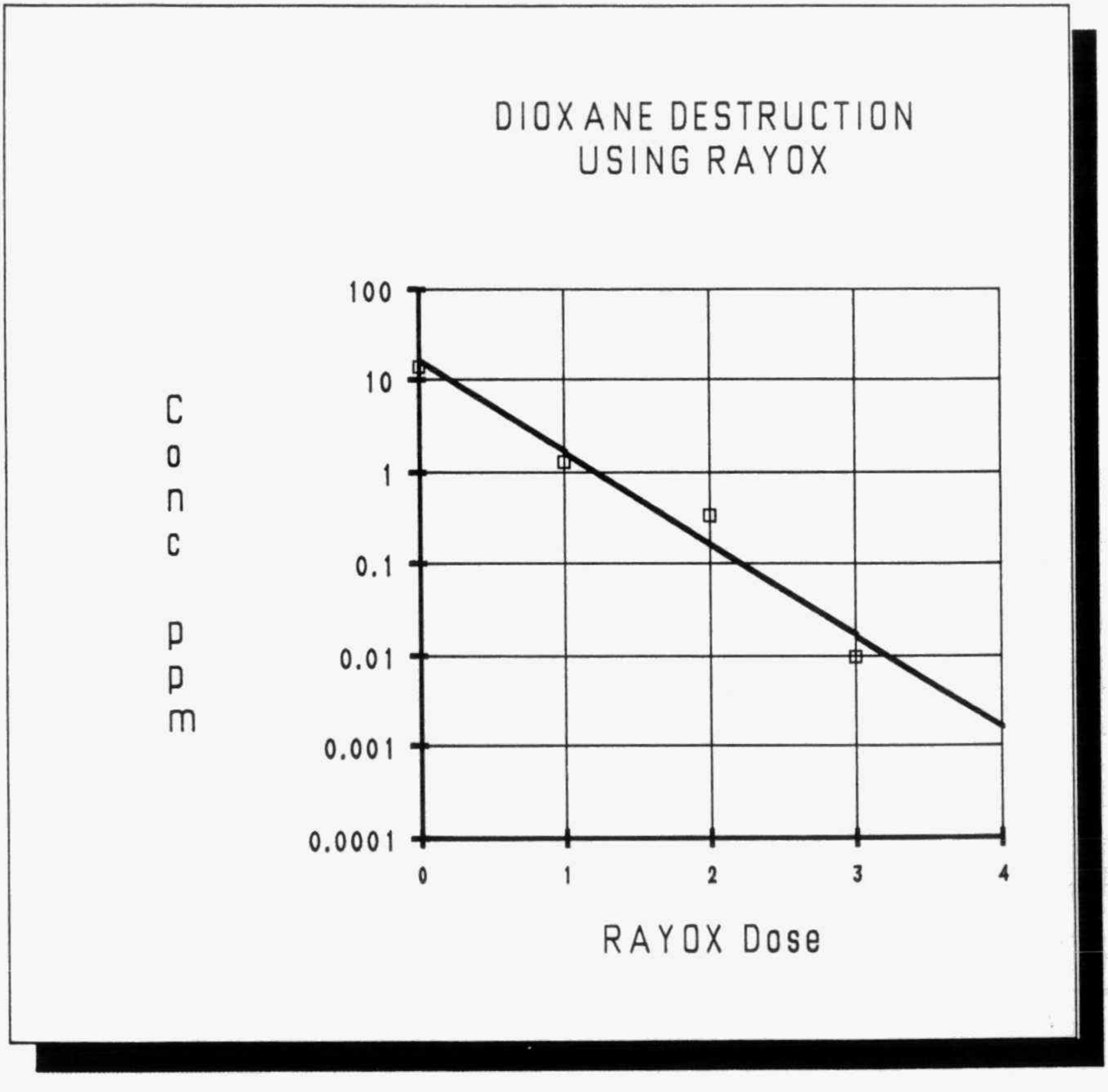
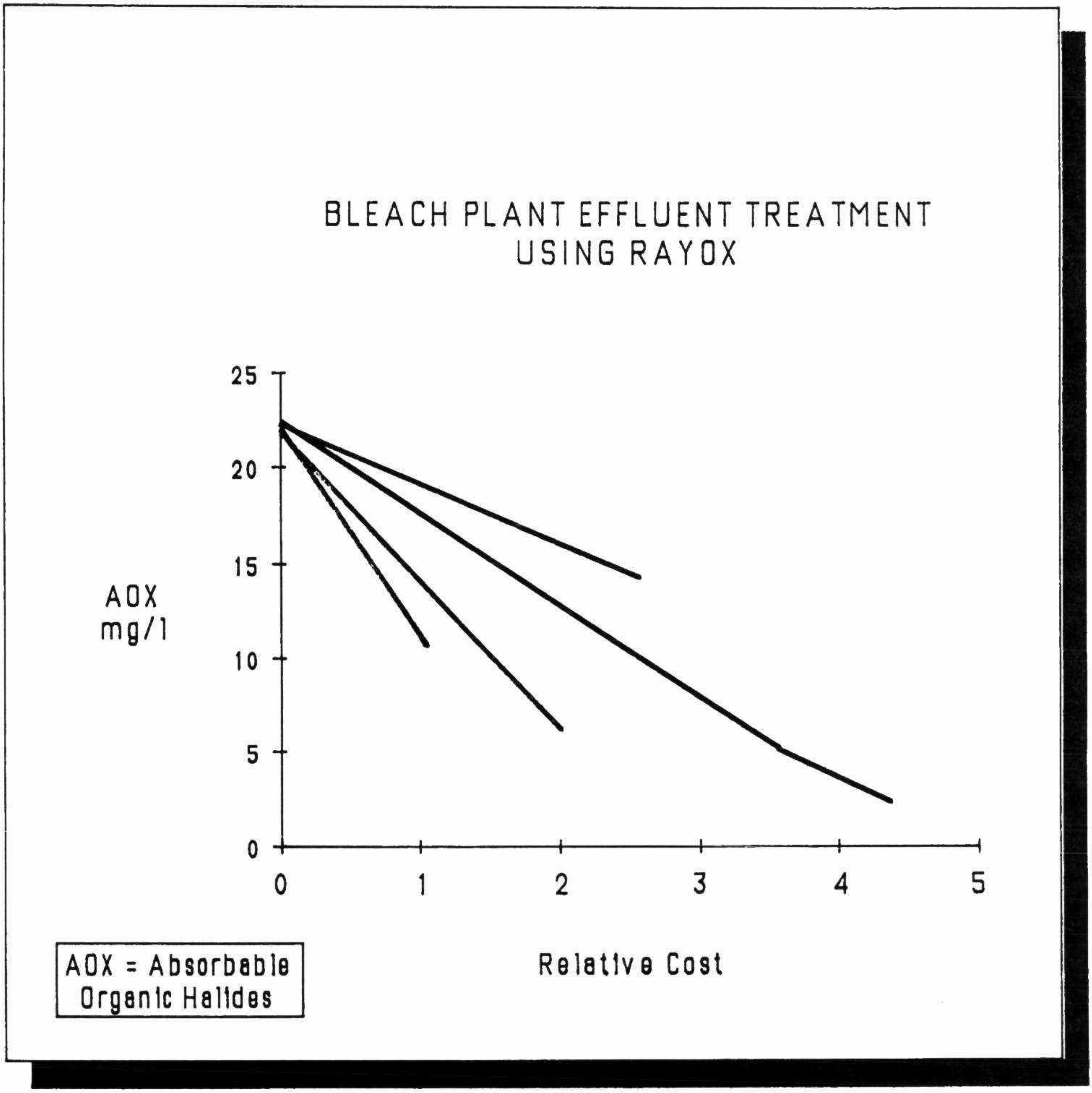

DIOXANE DESTRUCTION USING RAYOX
Conc ppm
100
10
1
0.1
0.01
0.001
0.0001
0
1
2
3
4
RAYOX Dose

Figure 6


BLEACH PLANT EFFLUENT TREATMENT USING RAYOX
25
20
15
10
5
0
AOX mg/l
0
1
2
3
4
5
Relative Cost
AOX = Absorbable Organic Halides

represent an attractive option for helping the industry meet the AOX reduction target.

PCB Contaminated Groundwater

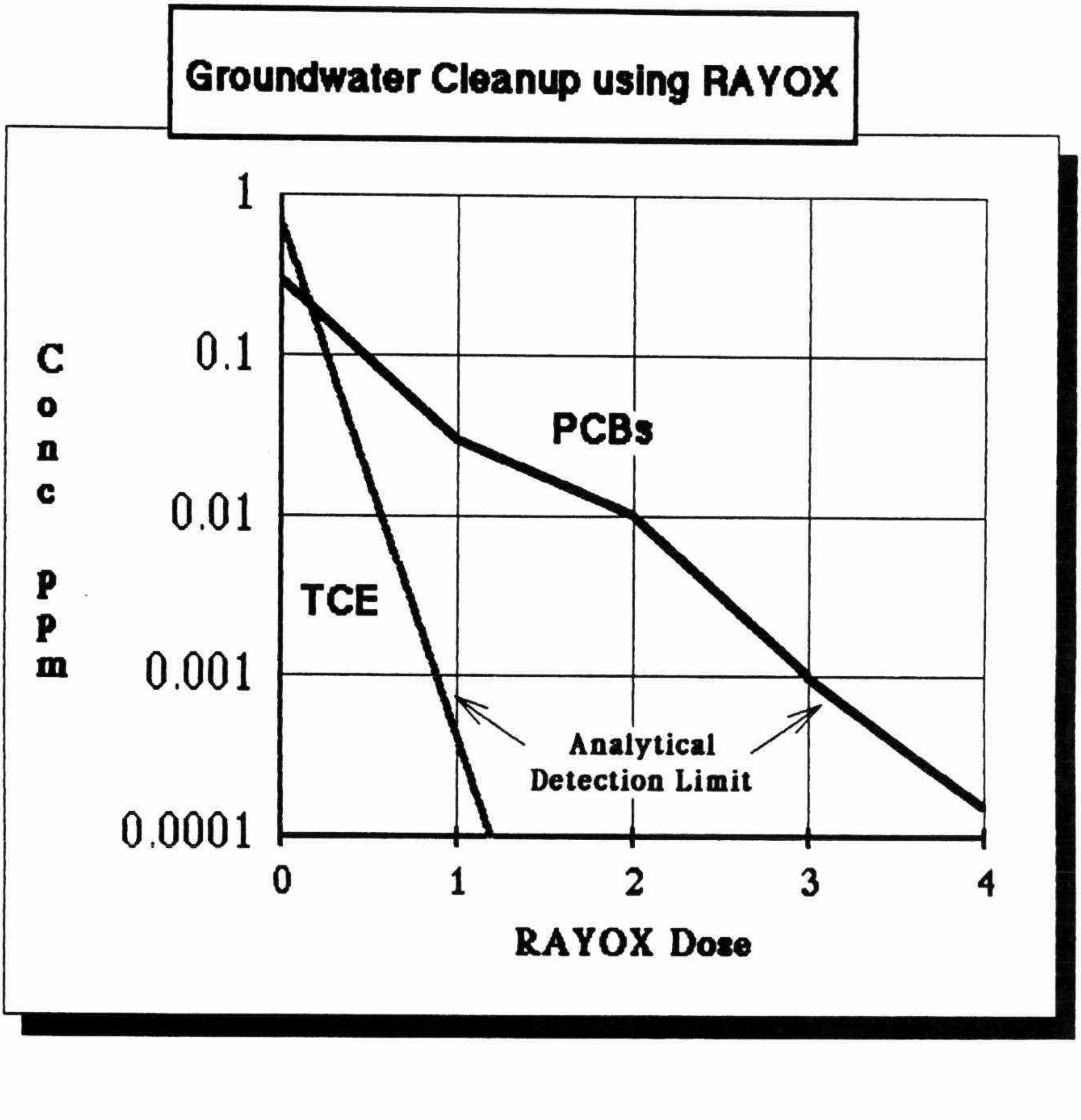
Preliminary results from recently completed design testing targeted on destroying PCB & (and some other chlorinated compounds such as DCB, $CHCL_3$ and TCE) in the Smithville PCB dumpsite groundwater are shown in Figure 7. These data demonstrate that the TCE and PCB concentrations can be straightforwardly reduced to below detection limit (~ 0.8 µg/l for TCE and ~ 0.6 µg/l for total PCB's) with **Rayox** process.

These results show the "deep cleaning" capability of **Rayox** and illustrate that virtually any degree of destruction is attainable with **Rayox**.

One of the more powerful advantages of using **Rayox** to destroy waterborne substances like PCB's and other toxics is that there is no secondary disposal problem.to deal with, as there would be with non-destructive techniques such as activated carbon.

A number of other examples could be cited where **Rayox** is becoming the treatment system of choice for on site destruction of toxic or hazardous contaminants in water, as the examples presented here are meant to be only illustrative of the breadth of application and powerful capability of the **Rayox** technology.

Figure 7


Groundwater Cleanup using RAYOX
Conc ppm
1
0.1
0.01
0.001
0.0001
0
1
2
3
4
RAYOX Dose
PCBs
TCE
Analytical Detection Limit

With its significant performance advantages over earlier enhanced oxidation equipment, and over traditional non-destruction techniques, it is suggested that those with a contaminated water problem consider its many benefits which include:

- Virtual zero discharge attainable at reasonable cost
  99.999 +% contaminant destruction

- No secondary disposal problems
  "in stream" contaminant destruction

- De-toxifies toxic effluent streams
  Rayox - treated output passes biological toxicity tests & HPLC/GC toxicity scans

- Broad spectrum applicability
  virtually all organic compounds as well as fixed and free cyanides

- Highly automated system
  requires essentially no operator time

- Very versatile system
  capacity can readily be turned up or down

- High degree of system safety
  built to CSA requirements,
  special safety features available

References

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MICROCOMPUTER-BASED REAL-TIME CONTROL OF COMBINED SEWER OVERFLOWS IN THE HAMILTON-WENTWORTH REGION

by
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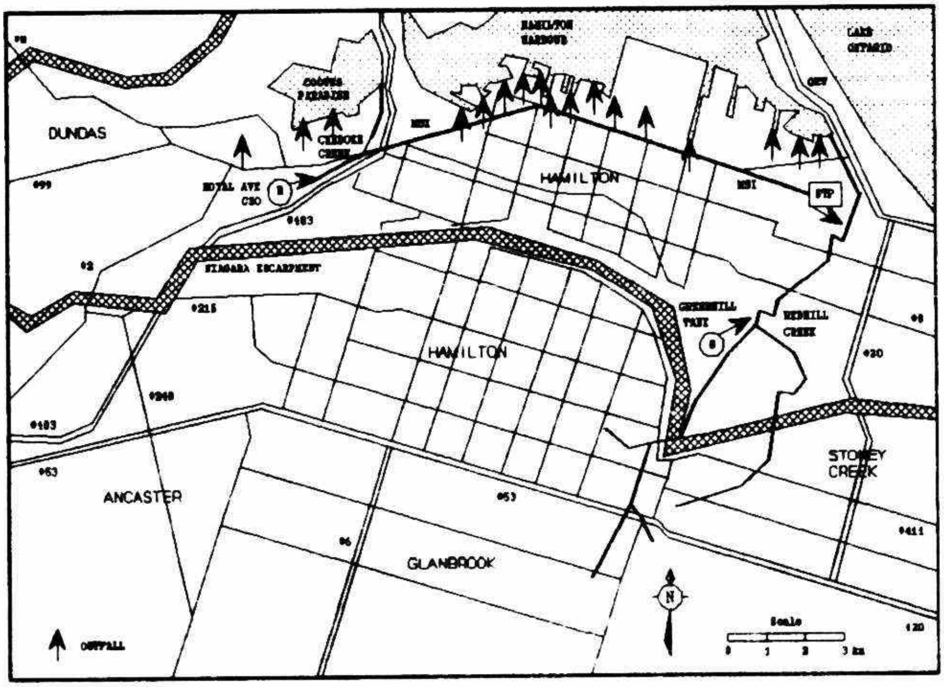
Engineering Department, Hamilton, Ontario

Many Ontarians reside in municipalities which are at least partially serviced by combined sewer systems which handle both stormwater runoff and sanitary wastewater. In these systems, during dry weather, all sanitary sewage is conveyed to local sewage treatment plants (STP) via large sanitary interceptor sewers. These interceptors were generally designed to handle 2 to 5 times dry weather flow. During wet weather, the combined discharge of stormwater runoff and sanitary wastewater often far exceed the capacity of the sanitary interceptors and STP. Diversion structures were typically built into the combined sewer systems to divert flows in excess of this capacity directly to local receiving waters. These discharges are commonly referred to as combined sewer overflows (CSO).

Hamilton's combined sewer system collects sanitary sewage and stormwater runoff from the older portions of the City, bounded by the Harbour headline in the north and the Niagara Escarpment in the south, and from the east end of the City above the Escarpment (see Figure 1). Many area industries also discharge wastewater to the combined sewer system. Separate sanitary and storm sewer systems have been installed in newer suburban areas. Combined sewage from most of the City is conveyed to the Woodward Avenue STP via the 14 km long Main Sanitary Interceptor (MSI) trunk sewer which runs along Burlington Street. During dry weather and small storm events, sanitary and storm flows receive full treatment at Woodward Avenue. Larger rainfall events, specifically high intensity, summer thunderstorms, which generate flows in the combined sewer system in excess of design capacities, may overload the MSI and/or STP, resulting in CSOs to Hamilton Harbour and Cootes Paradise. These diversions are necessary in order to avoid flooding the STP or surcharging the sewer system.

Figure 1: Hamilton-Wentworth Region



Common problems encountered in combined sewer systems include excess infiltration and inflow, sewer surcharging, solids deposition and scour, wet and dry weather CSO, and STP bypasses. Sewer surcharging often results in basement flooding and associated health hazards, public dissatisfaction and costly litigation. Overflows may result in temporary placarding of beaches (warning against swimming and other body-contact recreation) and may also adversely affect fish and wildlife habitats. Long-term deterioration of the environment through eutrophication, sediment contamination and adsorption of toxic chemicals by the biota may result from continued diversions. The Hamilton Harbour Remedial Action Plan (RAP) has identified CSOs as a significant source of ammonia, phosphorus suspended solids, and bacteria within the Harbour, and has recognized the need to reduce these overflows (Rodgers et al., 1988).

Popular remedies for CSO pollution problems include construction of separate storm sewers, storage, treatment, remote monitoring/control, or combinations thereof.

The construction of separate storm and sanitary sewer systems has been one of the most widely used remedies for CSO problems. However the separation of existing combined sewers is often an impractical and costly solution. Waller (1969) estimated that over $4.5 billion might be required to achieve complete separation of combined sewers in Canada. Furthermore, this solution does not adequately address the problem of pollution contributed by separated stormwater.

Storage can be an effective and economical CSO control technique. The concept generally involves the retention of CSOs during storm events, with their release to the sanitary interceptor permitted only after the storm has subsided, at which point the STP can treat the retained volume of wastewater. Types of storage include in-line storage, underground tanks, and above-ground retention tanks. Storage facilities can perform multiple tasks, such as primary treatment, flood protection, and sewer system relief. The Hamilton-Wentworth Regional Engineering Department has recently completed construction of a large CSO retention facility near Greenhill Avenue on the East Mountain (see Figure 1). The tank was designed to limit the frequency of CSOs into Redhill Creek at this site to once per year on average. Stored wastewater is subsequently released into the Redhill Creek Sanitary Interceptor Sewer and conveyed to the Woodward Avenue STP for treatment. Operation began in the Fall of 1987. The Region has retained a consultant to evaluate the actual performance of the facility.

Common treatment methods include physical/chemical treatment and disinfection using ultra-violet light or chlorine. These processes can be implemented at the existing STP as is usually the case, or at additional smaller facilities located at CSO outfalls.

Remote monitoring and control techniques are aimed at improving the operator's knowledge of the combined sewer system, and how it performs during a storm event, thereby allowing more effective control of CSO regulators and/or storage/treatment facilities. The Hamilton combined sewer system contains about 165 diversion structures, with 26 outfalls to local receiving waters (see Figure 1). A number of these structures employ motorized gates which can be opened or closed to regulate flow to the sanitary interceptor. These gates are either activated automatically by water level sensors, or remotely by operators at the Woodward Avenue STP. In the absence or more detailed information, the operator's decision is based upon general predictions, wet-well depths and flow readings at a various sites throughout the City (Henry, 1984). However, the dynamic spatial and temporal properties of rainfall events, especially summer thunderstorms, can generate runoff responses where some sections of the sewer system are overloaded while others, which may be in close proximity, are flowing at well below capacity. Without adequate knowledge of the direction, speed, and extent of a thunderstorm, gates may be closed well before the sanitary interceptor's capacity is fully utilized, and may remain closed long after flow subsides. While such a procedure results in maximum safety for the STP and a lower probability of basement flooding, CSO frequencies and volumes are likely greater than necessary. More precise control of automatic CSO regulators should provide the capability to optimize use of the sanitary interceptor, thereby reducing CSO, while still maintaining the desired protection against STP overload and basement flooding.

The advent of low-cost microcomputers has introduced the possibility of economically controlling CSO diversion structures and/or storage in real-time to minimize CSO in wet and dry weather. To date, this approach has not been sufficiently tested in Ontario. In 1987 the Region made application to the Ontario Ministry of the Environment (MOE) for funding of a demonstration project to evaluate microcomputer-based real-time control (RTC) of combined sewer overflows. The site chosen for the project was the Royal Avenue diversion structure in West Hamilton. The study was approved by Regional Council and the MOE in 1987 and work began in 1988. This paper outlines the objectives and scope of the demonstration project and the proposed approach to the problem.

STUDY AREA

The City of Hamilton is one of Canada's major industrialized urban centres. The City includes two of North America's largest steel makers, Stelco and Dofasco, and supports a population of well over 300,000. The area's topography is characterized by a number of major natural features which influence land use and drainage patterns, the most influential of these being the Niagara Escarpment. The Escarpment divides the Region into upper and lower sectors, which have an average difference in elevation of about 108 m. The terrain of both the upper and lower portions of the area are nearly flat. The Escarpment is cut by a number of deep valleys, the most significant of these being the Dundas Valley. The area generally drains eastward or northeastward to the receiving waters of Hamilton Harbour and Cootes Paradise (see Figure 1).

Prevailing winds are generally from the southwest. On an annual basis, southwest winds occur about 37 percent of the time and dominate the period the period from July to January. Wind speeds are generally between 10 to 20 km/hr. The most significant sources of atmospheric pollution are the heavily industrialized area on the south shore of the Harbour, and the Central Business District (Shivalingaiah and James, 1986). Northeast and east winds play an important role in distributing airborne pollutants over the City. Hamilton is also extremely susceptible to atmospheric inversions, caused by differential heating of the lake and land surfaces (Rouse and McCutcheon, 1972). These inversions may result in increased surface pollutant buildup and washoff.

The significance of storm speed and direction on the response of Hamilton's storm and combined sewer system to thunderstorms has been studied in great detail. Robinson and James (1984) used the Stormwater Management Model (SWMM) developed by the U.S. EPA (Huber et al., 1981) and the RAINPAC package developed by Scheckenberger (1983) to determine the sensitivity of the response of a portion of Hamilton's combined sewer system to storm speed and direction. SWMM is a deterministic simulation package which generates surface runoff and pollutant washoff from user supplied rainfall hyetographs, based on land use, topography, and antecedent conditions. Hydrographs and pollutographs can be routed through a network of manholes, lift stations, overflow structures, storage facilities, and various shapes of conduits, as defined by the user. SWMM is one of the best known and most widely used urban runoff quantity and quality models. RAINPAC is a set of dynamic spatially variable rainfall models which can be used to prepare rainfall hyetographs for water quantity and/or quality models such as SWMM, accounting for:

- Storm cell speed and direction;
- Storm cell direction;
- Growth and decay of peak rainfall intensity;
- Growth and decay of storm's areal coverage;
- Multiple storm cells.

Figures 2 and 3 illustrate the effects of varying the direction and speed of a hypothetical thunderstorm event on the response of the Chedoke Creek Drainage Basin in West Hamilton. The Royal Avenue CSO Diversion Structure is located within this catchment. A storm coming from the southwest, and thus following the general direction of the drainage network, will result in significantly higher peak flows than a similar storm coming from other directions (see Figure 2). In addition, a critical storm speed exists for the drainage basin, where storm travel time over the basin is comparable to its characteristic runoff response time. Figure 3 indicates that storms travelling at between 10 and 20 km/hr will generate the highest peak flows. A given storm will thus yield the highest peak flows when travelling at 10-20 km/hr, in the direction of the drainage network, i.e. from the southwest. When such a storm occurs, peak flows from the sub-drainage basins in the catchment arrive at the downstream end of the system at the same time, yielding higher peak total flows. This should not be thought of as an unusual occurrence. In fact, summer thunderstorms in Hamilton generally come from the southwest (Scheckenberger, 1983; Nimmrichter, 1986), and storm speeds of 10-20 km/hr are quite common.

The automatic diversion structure located at the eastern end of Royal Avenue, near the intersection with Stroud Road, has been chosen to demonstrate the feasibility of microcomputer control of CSO diversion structures. The Royal Avenue Diversion Structure drains an area of approximately 600 ha, divided by the Niagara Escarpment (see Figure 4). The area below the Escarpment is serviced predominantly by combined sewers, while the drainage network above the Escarpment is entirely separated. Combined sewers service approximately 35 percent of the basin. Separated stormwater runoff and combined sewage are conveyed to the CSO structure via the same 9'6" x 7'9" trunk sewer. During smaller storms, these flows are separated by a 2' high wall which divides the sewer. During larger events, flow depths may exceed 2', and the two flow streams will be mixed. The CSO regulator at Royal Avenue utilizes a motorized gate to control the flow of combined sewage from the trunk sewer to the interceptor. Excess flows are diverted, untreated, to the Chedoke Creek Channel at the trunk sewer's outlet.

Figure 2: Storm Direction Comparison

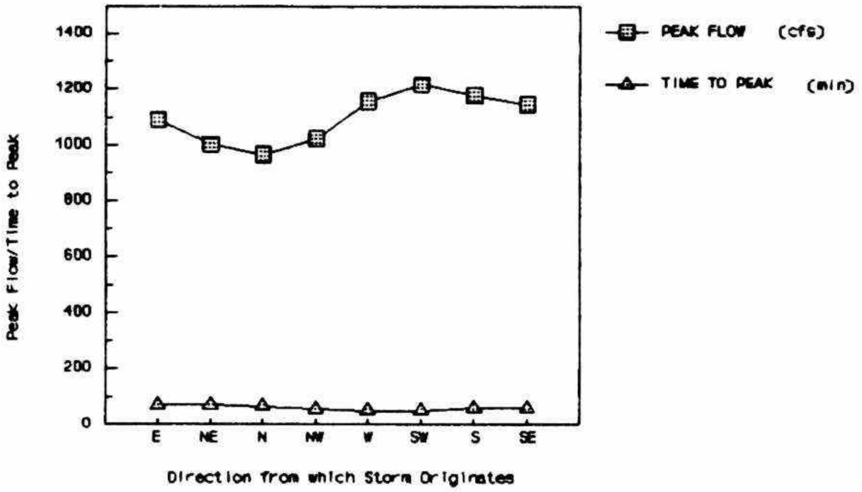


Figure 3: Storm Speed Comparison

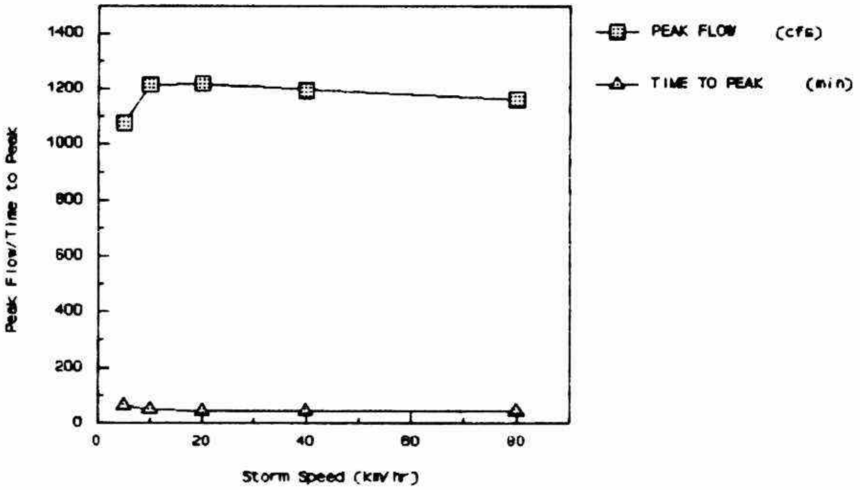
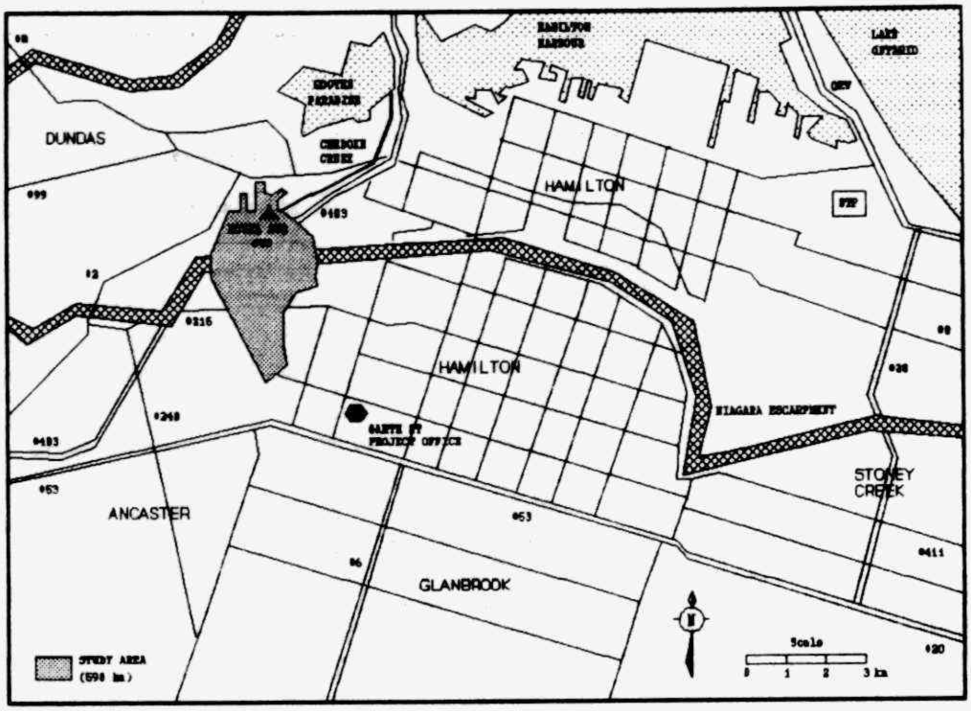


Figure 4: Study Area Location



STUDY OBJECTIVES AND SCOPE

The primary objectives of this demonstration study are:

1) To design a microcomputer-based RTC system for managing CSO diversion structures;

2) To install, operate and evaluate the RTC system at the Royal Avenue CSO diversion structure for the purpose of demonstrating the practical application of this particular technology;

3) To develop a theoretical operating strategy for a larger portion of Hamilton's trunk sanitary interceptor, based on the technology developed for the pilot site;

4) To produce a document which will facilitate transferral of this technology, with emphasis on medium-sized municipalities in Ontario.

While the evaluation of the RTC system at Royal Avenue will be based mainly on its ability to reduce CSO to local receiving waters, the primary purpose of the project is to test the feasibility of this new technology, not to completely solve Hamiliton's CSO pollution problem.

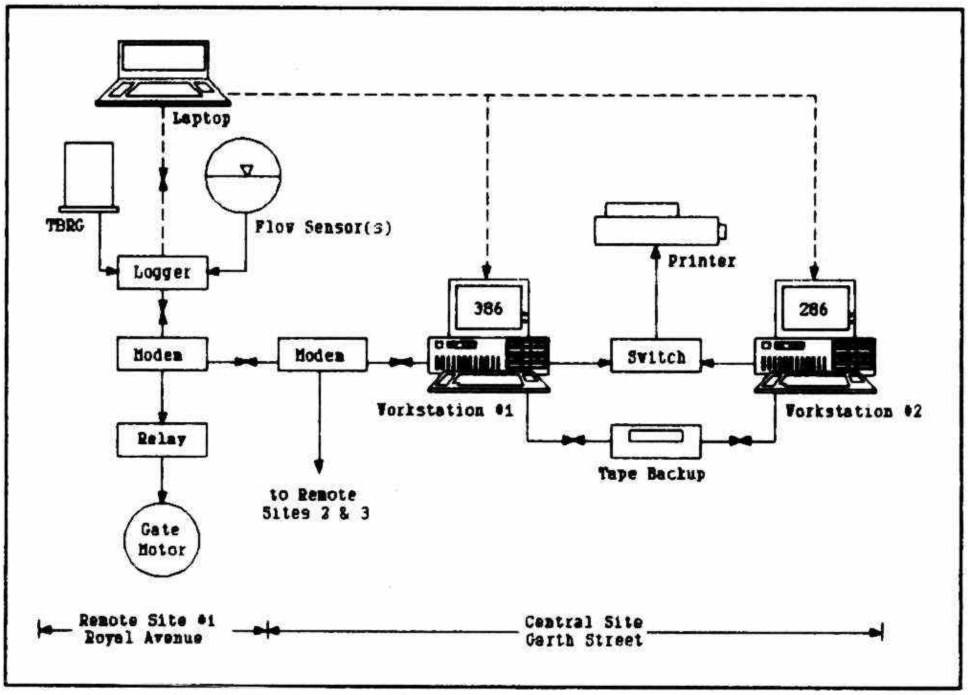
APPROACH

As currently envisioned, the RTC system at the Royal Avenue CSO Diversion Structure will include the following hardware and software components:

1) Real-time monitoring network and telemetry system;
2) Microcomputer controller and interface with monitoring network and gate;
3) RTC operational model, including real-time water quantity and/or quality forecasting and database management.

Figure 5 presents a schematic of the hardware configuration proposed for the RTC system. The central control site will be located at the Garth Street Reservoir project office (see Figure 4).

Figure 5: RTC System Hardware



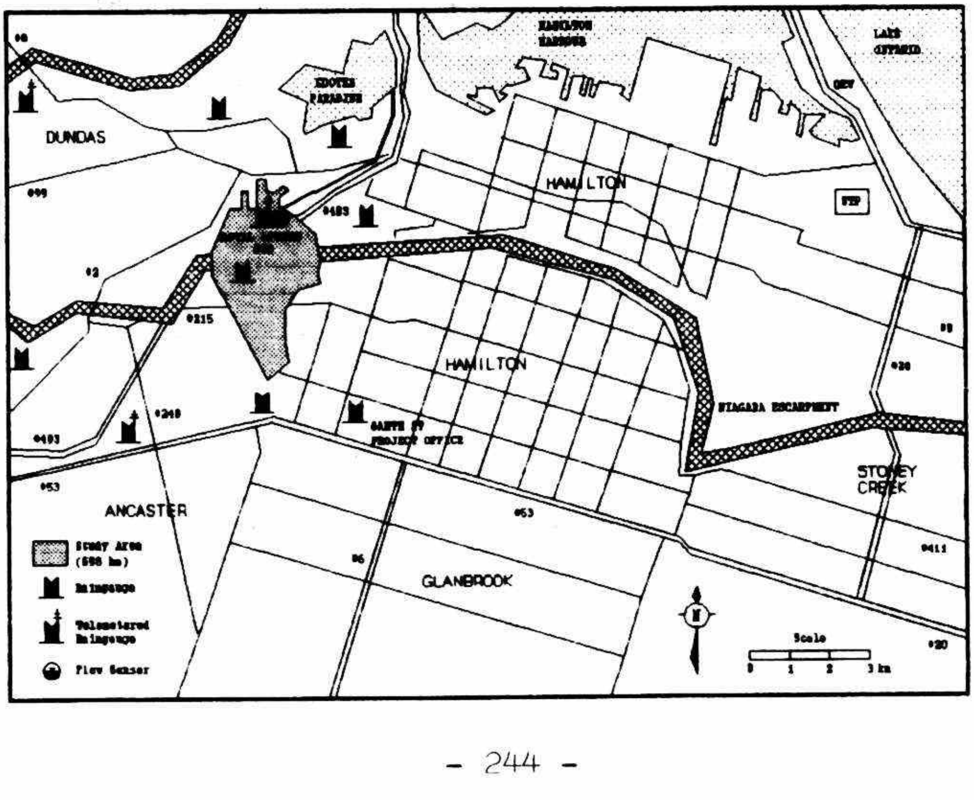
Hydrometeorologic Monitoring Network

A monitoring network comprising at least 10 raingauges, 2 automatic water level/flow sensors (both located at Royal Avenue) and 1 automatic water quality sampler is to be installed and operated. At least 3 of the raingauges will be connected to the central control site by modem and telephone line to permit real-time collection of rainfall data. The water level/flow sensors will be similarly connected.

Appropriate knowledge of storm dynamics is essential for hydrologic modeling and forecasting. For successful control of CSOs, this information must be made available in real-time, at very frequent intervals (say every 1-5 minutes). The raingauge network must be dense enough to accurately describe the spatial and temporal variabilities of storm events. The raingauges themselves must provide sufficient resolution of rainfall over a wide range of intensities. They should also be solidly constructed and suitable for unattended outdoor use. The signal produced by the raingauges must be compatible with electronic data loggers. After reviewing available rainfall sensors, the project team purchased 10 tipping bucket raingauges (TBRG), each with a 0.2 mm rainfall resolution, accurate to 1 percent of the bucket volume. These gauges measure rainfall rates between 0 and 380 mm/hr. The complete network of 10 raingauges cost approximately $13,000.

The raingauges were installed in late April. In most cases the gauges are located on the roofs of municipal facilities, i.e. sewage pumping stations and reservoirs. An enclosure was constructed at the Royal Avenue site, where the raingauge sits atop the regulator chamber, just above ground level. The locations of the 10 rainfall monitoring stations are shown in Figure 6. The 8 outer raingauges were situated to create a ring around the catchment, providing information relating to storm speed, direction, intensity, and coverage. The 3 westernmost stations were located further from the catchment to obtain advance information pertaining to storms coming from the southwest, the prevailing storm direction in the area. The 2 gauges located within the catchment provide the detailed information required to forecast flows arriving at the Royal Avenue CSO Regulator, i.e. the amount of the rainfall falling on the catchment. The orientation of the 10 gauges should quicken the process of determining storm speed and direction and facilitate real-time flow forecasting.

Figure 6: Location of Monitoring Stations



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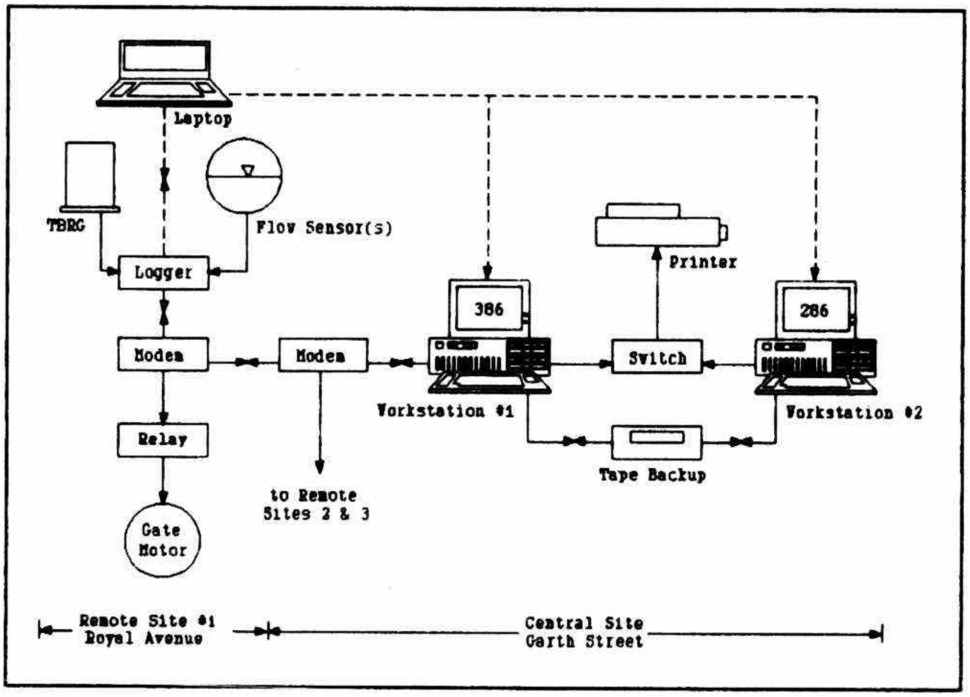

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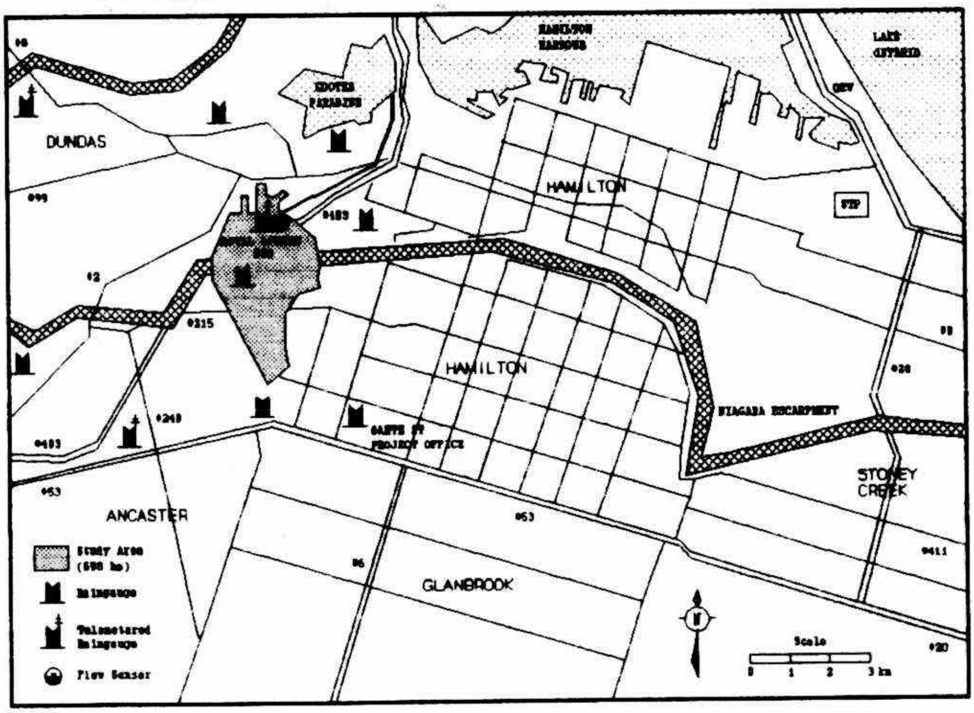

As storm speed and direction are often closely correlated to wind speed and direction, anemometers may also be useful to the RTC system in determining storm dynamics. The project team will investigate the benefits of adding anemometers to some or all of the monitoring stations.

Electronic data loggers are necessary to transfer the signals from these sensors into numerical quantities and temporarily store the results. Permanent storage of this data is best left to more powerful microcomputers. The data loggers must thus provide a convenient means of transferring the data to other microcomputers. Some stations will be connected to the central control site via modem and telephone line. It is anticipated that all sites will be visited weekly or bi-weekly to retrieve data with a portable microcomputer. The data loggers should provide enough storage to handle the data collected during these unattended periods. In addition, to protect against loss of data during power failures, the units should operate on both AC and DC current, and require very little power. The batteries should be rechargeable and have long lives.

Rainfall sensors transmit pulse count (digital) signals. Anemometers, which measure wind speed and direction, and sensors which measure fluid levels/flows and pollutant concentrations, or detect valve positions, transmit an analog signal. As some of the monitoring stations may incorporate a number of these sensors, the data loggers should provide several digital and analog input channels. An automatic water quality sampler will be installed at Royal Avenue to characterize the pollutional strength of the CSO at this site. The data logger should provide a means of triggering the automatic sampler, when say, a critical water level is reached.

Rainfall intensities will generally be averaged over a one-minute timestep. For water levels/flows and/or pollutant concentrations, sampling intervals of five minutes or more may prove adequate. Sampling frequencies for the digital and analog input channels should therefore be software selectable. The data loggers should have built-in real-time clock/calendars to ensure proper time synchronization of the various monitoring stations.

After reviewing a number of different data collection units, the project team purchased 10 portable electronic dataloggers, each with a 10 Volt rechargeable battery pack, 120 Volt AC adaptor/charger, 32 kBytes of solid-state memory, a low-drift real-time clock/calendar, individually software selectable digital and analog input channels (8 of each), a voltage regulated output control, and a 4800 baud modem connection. RS232 serial communications with other microcomputers (including IBM-PC compatibles) is supported through a direct connection with the aid of a serial communications interface, or via modems on dedicated or dial-up telephone lines. IBM-PC-based software is provided to facilitate data transfer and processing and can also be used to remotely configure or reprogram the dataloggers. Processing of recorded information to generate graphs and data tables can be performed on-site for immediate viewing, if desired.

The operational model which will drive the RTC system requires frequent transmission of information to a central site from points within the drainage basin, including wind speed and direction, rainfall intensity, water level/flow, pollutant concentration, and regulator status. Thus, a means of communicating this information to the central site is necessary. The data loggers purchased by the project team can be accessed via modem over dial-up or dedicated telephone lines by a microcomputer and modem located at the Garth Street Reservoir project office. Initially, 3 real-time monitoring stations will be set up within the study area. Modems were purchased with the dataloggers for these stations. Data will be retrieved from these sites via dialed public telephone lines at 1200 baud. Should the occasional unavailability or the quality of public telephone lines limit the performance of the RTC system, leased telephone lines will be utilized.

The entire system, comprising ten dataloggers, each with batteries and chargers, three 1200 baud modems, one RS232 serial communications interface, and the IBM-PC-based software cost under $17,000.

In any telemetry and remote control system, the software which handles data transmission is very important. The software handles communications protocol, checks the data for errors upon receipt, and ensures data transmissions are properly synchronized such that data loss due to signal collisions is minimized, or otherwise accounted for. Communications software provided with the dataloggers purchased by the project team handles these tasks. Software has also been developed by the project team to suit more specific study requirements. In addition, with the aid of either software package, the central microcomputer can reconfigure each of the dataloggers at any time, providing new operating instructions (eg. changing sampling intervals, communications protocol, etc.). New operating characteristics can be verified by the central microcomputer. When the central computer has terminated communications, the datalogger will disable its communication operation and return to its datalogging function. Real-time communications software is currently being developed by the project team.

A portable microcomputer provides the most efficient means of retrieving data from the other seven monitoring stations, and can also be used to program the dataloggers in the field (eg. select timestep, communications protocols, etc.). After reviewing available hardware, the project team purchased an IBM-PC compatible laptop microcomputer, outfitted with 2 floppy disk drives, a serial communications port, a rechargeable battery and a car cigarette lighter power adaptor, at a cost of about $2,000. The car cigarette-lighter adaptor was purchased to recharge of the laptop's batteries while field staff travel from site to site to retrieve data from the loggers. Data which has been stored in the datalogger is downloaded to the laptop's serial port via the RS232 serial communications interface using the aforementionned software. By transmitting simple instructions through this communications link, the laptop can modify the operating characteristics of the dataloggers, and verify the new configuration.

The laptop also allows field staff to perform some simple data processing and display the data graphically while they are at the field sites. This allows prompt identification of any instrument difficulties. Minor problems can then be addressed immediately and the laptop can be used to verify their resolution before departing the site. Instruments in need of more major repairs can be taken back to the project office and repaired.

Upon returning from the field sites, the data is transferred to a desktop PC at the central site for further processing and archiving. Data processing software has been developed by the project team to separate the rainfall records into distinct storm events. The applicability of smaller, less expensive, hand-held microcomputers to field data retrieval may be investigated by the project team.

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Microcomputer Hardware

A powerful desktop microcomputer is required to serve as the central processor for the RTC demonstration system at the Royal Avenue CSO Diversion Structure (Workstation #1). This machine, hereinafter referred to as the Central Microcomputer Controller (CMC), will be required to perform the following tasks every 1 to 5 minutes:

1) Communicate with and retrieve data from a real-time monitoring network comprising at least 3 raingauges and 2 water level/flow sensors via modem and telephone line;

2) Using this data, predict important wind and/or rainfall characteristics within the study area, and resulting water levels/flows at the overflow structure, ahead of time;

3) Based on the predicted information, determine the optimum gate control strategy, and if necessary, send a signal to the overflow structure via modem and telephone lines to move the motorized gate to the desired position (an electrical relay will be required to activate the motor);

4) Archive information pertaining to rainfall intensity, water level/flow, and gate position in a data base management system;

5) Present important information clearly, with the aid of colour graphics, to allow intervention by a supervisor, where necessary.

As the complexities of the RTC system are unknown before its development and testing are completed, hardware was selected so as not to restrict the use of more advanced and computationally intensive techniques should research indicate they are necessary to achieve the desired results. The CMC requires high computational speed, large disk storage, high resolution colour graphics, and should be IBM-PC compatible. After reviewing available hardware, the project team purchased a 25 MHz, 80386-based desktop PC, outfitted with a high speed math co-processor, a 110 MB RAM hard disk drive, a high resolution VGA colour monitor and controller, and a 1200 baud modem. The modem will allow the CMC to communicate with at least 3 dataloggers located within the study area. The cost of fully equipping Workstation #1 was about $17,000.

A second microcomputer is required to carry out every day tasks related to the development of the RTC system (Workstation #2). Tasks will include:

1) Long-term continuous simulations to generate continuous water quantity and quality records;

2) Storage and management of rainfall, water level/flow, and/or pollutant concentration data collected from at least 10 stations;

3) Statistical analysis of long-term records and continuous simulations to develop a real-time rainfall-runoff forecasting model;

4) Continuous simulations to evaluate alternative control strategies;

5) Development and testing of specialized software related to the above tasks.

A fast processor and large hard disk drive are necessary to undertake the long-term simulations and manage the related input/output, which can reach up to 5 MBytes per file. After reviewing available hardware, the project team purchased a 6-10 MHz, 80286-based desktop PC, and outfitted it with a high speed math co-processor and 40 MByte hard disk drive. The cost of fully equipping Workstation #2 was about $5,000. Prior to being dedicated as the CMC, Workstation #1 can be used to perform similar tasks as Workstation #2.

Workstation #2 may also be linked to the CMC to provide backup in case of CMC hardware malfunctions. This may require development of a second, less complex RTC operational model, which could run on the 80286-based PC. Power outages and surges, which would affect both Workstation #1 and #2 may have to be protected against by an uninterruptable power supply (UPS). A UPS system will be purchased in the future if deemed necessary.

Should the demonstration project indicate that the RTC system does not fully utilize the computing power provided by the 80386-based machine, less powerful, less costly alternatives (for the CMC) should be investigated. The 80286-based PC provides an opportunity to do so. After successfully installing and testing the RTC system on Workstation #1, the project team will attempt to install the same system on Workstation #2 and evaluate its performance (as the CMC).

Real-Time Control System Software

A centralized database management system (DBMS) will be developed by the project team to process, store and retrieve data. This system will be required to handle two different tasks:

1) Management of a permanent database, containing all collected rainfall and water quantity and quality data;

2) Interim management of telemetered data to provide an interface with the RTC operational model and the permanent DBMS.

Software will be developed to allow the CMC to retrieve data from the telemetered sites in real-time, every 1 to 5 minutes. This data will provide input to the rainfall-runoff forecast model. Data from the remote raingauge stations is collected in the field using the laptop microcomputer and subsequently transferred to the permanent DBMS, which resides on Workstation #2.

A suite of water quantity/quality models is being assembled which will allow the following tasks to be completed:

1) Estimation of current (i.e. no RTC) CSO frequency and volume to provide a basis for evaluation of theoretical RTC system performance;

2) Generation of continuous rainfall-runoff timeseries to provide a basis for development of a real-time rainfall-runoff forecast model;

3) Development of a RTC simulation model which incorporates the forecast model and allows the theoretical evaluation of the performance of any number of proposed operational strategies over a lengthy continuous period.

The models will be capable of simulating storm dynamics, rainfall-runoff processes, flow routing, in-line and off-line storage and the hydraulic operation of diversion structures, in continuous mode. The RUNOFF and TRANSPORT modules of PCSWMM3 (James and Robinson, 1985) will likely form the basis for the model package, but additional software development may be required for specialized processes. RAINPAC (Scheckenberger, 1983) will be used to analyze storm directions and speeds and aid in calibrating the water quantity/quality models. Flow forecasts in the trunk sewer at Royal Avenue will be generated from previous measured rainfall intensities and predicted and/or measured flowrates. Once actual flow readings are available, they will be substituted for corresponding flow predictions or used to recalculate forecast model parameters. Repeated every timestep, this will provide the model with a self-correcting feature to ensure that runoff forecast errors do not accumulate. The PCSWMM3 EXTRAN module will be used to simulate the effects of the proposed RTC system on the hydraulic grade lines in the combined sewer system during the larger storms.

Field Demonstration and Evaluation

After identifying the optimum theoretical control strategy the RTC system will be installed at the Royal Avenue CSO Diversion Structure for the purpose of verifying its performance in the field. Before testing the entire system, the operation of individual hardware and software components will be verified under controlled conditions. The reliability of the system will then be evaluated during actual storm events. Data will be collected during storm events to verfify the results obtained by simulation.

Based on the performance of the proposed RTC system, a theoretical operating strategy for a larger portion of Hamilton's trunk sanitary interceptor will be developed. This task will be conducted exclusively as a modeling exercise.

Finally, a document will be prepared, aimed at facilitating transfer of this technology to other municipalities. As most of the Ontario communities which are still serviced by combined sewer systems have populations in excess of 50,000, emphasis will be placed on medium-sized municipalities.

ACKNOWLEDGEMENTS

The authors would like to thank the Ontario Ministry of the Environment (MOE) and the Regional Municipality of Hamilton-Wentworth for providing the necessary funding for this demonstration project. Funding is provided equally by the two parties. MOE funds are provided through the Province's Pollution Control Planning (PCP) Studies Program.

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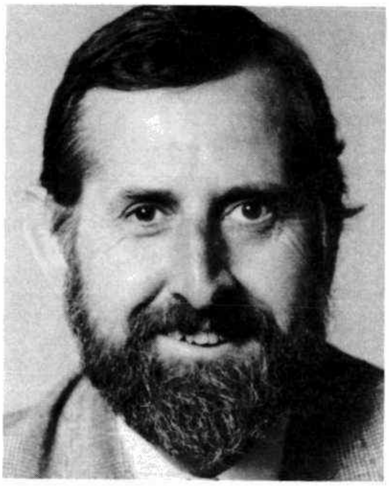
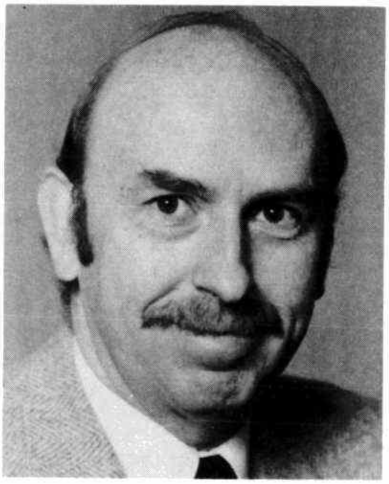
SESSION V – RECYCLING

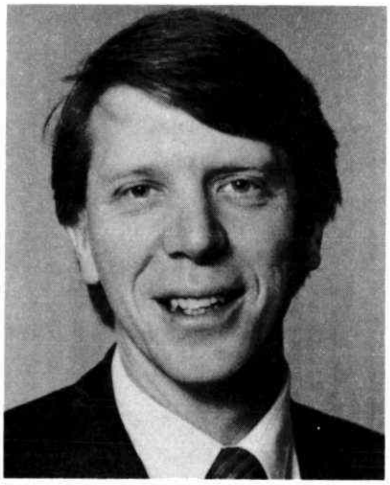


Moderator: Dr. R. Laughlin, Manager
Canadian Waste Materials Exchange
ORTECH International, Mississauga

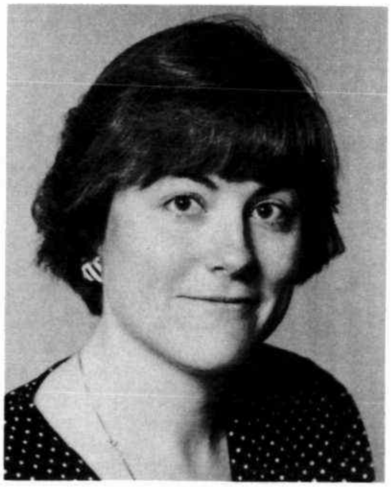


N. Ahlberg, Manager
Technology Section
Waste Management Branch
Environment Ontario

R. Flemington, President
Ontario Multi-Material Recycling Inc.
Toronto, Ontario

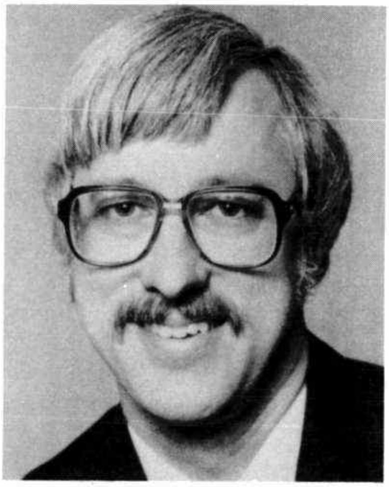


W. Heeley, President, Heating,
Refrigerating, and Air Conditioning
Institute of Canada
Etobicoke, Ontario



M. Stewart, Asstistant Recycling
Coordinator, Refuse Disposal Division
Metro Works Department
Toronto, Ontario

D. Peel, General Manager
Manufacturing, Breslube Division
Safety-Kleen Canada Inc., Breslau



Dr. D.W. Brinkman, Manager
Oil Technology & Technical
Development, Safety-Kleen
Canada Inc., Breslau, Ontario

UPDATE ON INDUSTRIAL 4R'S PROGRAM

by

N. Ahlberg, Manager, Technology Section,
Waste Management Branch, Environment Ontario

THE COMPREHENSIVE FUNDING PROGRAM FOR WASTE MANAGEMENT FACTS FOR INDUSTRIES

Environment Ontario is committed to supporting industries - and other agencies or interests - in projects designed to benefit Ontario's environment.

In June 1987, the Ontario Government announced its comprehensive funding program for waste management. The new program will provide industries and municipalities with financial assistance for reduction, reuse, recycling and recovery of wastes (the 4Rs) as well as new or improved municipal waste treatment/disposal facilities.

Industrial 4Rs Initiatives

For 4Rs initiatives, assistance is now available for both industries and municipalities. In the municipal area, existing programs such as the Municipal Recycling Support Program (MRSP) have been improved, while new programs for municipal waste recovery and reduction/reuse activities were introduced.

While some of the municipal 4Rs programs have been in effect for several years, the industrial 4Rs assistance program is new. In 1986, the Industrial Program Unit was formed within Environment Ontario's Waste Management Branch. Its principal role is to assist industries in projects that will help them to implement the 4Rs waste management philosophy. The new industrial 4Rs program will provide the financial and technical assistance that industries need to develop environmentally sound waste management systems with increased emphasis on the principles of the 4Rs.

Overview of Municipal Assistance Programs

There are three new initiatives in the areas of municipal waste treatment and disposal:

- The new Financial Assistance Program (FAP) will provide assistance to municipalities for developing new facilities, or for expanding existing facilities such as landfills, transfer stations and processing facilities.
- There will be an increased emphasis on the present Waste Management Improvement Program (WMIP) to upgrade existing municipal sites, to close sites, and to do investigative studies or provide remedial measures at active sites.
- There will also be an increased emphasis on the present Waste Management Master Plan (WMMP) program to assist municipalities, or groups of municipalities, in long-range waste management planning.

Forms of Assistance for Industries

- Assistance to industries may be provided by financial grant, technical advice, information or any combination of these.
- Assistance may be considered on a case-by-case basis for seminars and workshops on industrial recycling.

Proponents Eligible for Assistance

- All industrial/commercial sectors may apply for assistance.
- Consulting firms may also apply whether or not the application is on behalf of a specific industry.
- Municipalities, or proponents working under contracts with municipalities, may not apply under this program component as the municipal initiatives are available to them.

Eligible Projects/Proposals

- Feasibility studies
- Reduction, reuse, recycling or recovery of wastes
- Process or equipment modification or evaluation
- Demonstration of technology
- Upgrading existing operations beyond current state-of-the-art for a particular industry
- Research

Eligible Costs

- Capital costs - potential grants will match proponent's dollar contribution up to a maximum of 50 per cent of the total eligible cost.
- Start-up (commissioning) costs - up to a maximum of 50 per cent.
- Demonstration/Evaluation of Technology/Process - up to 100 per cent of a proponent's eligible costs for a defined time period necessary to demonstrate/evaluate the proposal.
- Research - up to 100 per cent of proponent's eligible costs.

Non-eligible Costs

- Land and/or servicing costs.
- Financial support to obtain licenses or patents.

For More Information

Contact Environment Ontario, Waste Management Branch, Industrial Program Unit, (416) 323-5200.

Environment Ontario regional offices:

Kingston: (613) 549-4000
Sudbury : (705) 675-4501
Hamilton: (416) 521-7640

London : (519) 661-2200
Thunder Bay: (807) 475-1205
Toronto : (416) 424-3000

Ontario Ministry of the Environment

Waste Management Branch

The Industrial 4Rs Program

A Summary of Projects Supported as of May 31,1989

INDUSTRIAL 4Rs FUNDING PROGRAM

CAPITAL PROJECTS (as of May 31, 1989)

TYPE OF PROJECT	MATERIALS DIVERTED	# of PROJECTS FUNDED	MOE FUNDING	ANTICIPATED WASTES DIVERTED PER ANNUM		
				HAZARDOUS		NON-HAZARDOUS
				(Tonnage)	(Litres)	(Tonnage)
Corrugated	Corrugated containers	10	$245,025			27,890
Paper	Fine Paper, Newspaper	3	$107,390			14,300
Tire/Rubber	Tires	1	$445,210			30,000
Composting	Pulp Mill Sludge, Wood	1	$540,990			30,000
Electroplating/ Metal Finishing/ Circuit Boards	Copper, Nickel, Chromium, Cadmium, Zinc, Tin	14	$437,229	1,446	357,200	
Metals	Lead (batteries) Copper (wire) Aluminum (smelting, automotive, wire) Zirconium, Tin	5	$606,550	14,082		2,520
Solvents/Paint	CFC's, Propanol, Freon, Acetone	5	$127,875	12	3,444,600	
Multi-Materials Collection	Food Packaging, Paper, Glass, Metal cans, Wood, Plastic, Corrugated cardboard	2	$305,000			22,500
Foundries	Foundry Sand	1	$30,000			6,000
Demolition/ Construction	Plaster, Wood	2	$163,500			7,000
Wood Wastes	Pallets, Wood waste	6	$687,602			96,780
Animal Products	Protein, Blood	2	$108,575	500	1,700,000	
Ceramics/Clays	Clay	1	$101,300			1,450
Glass	Glass Collection	2	$30,700			3,025
Plastics	Nylon, Leather, PE, PVC, Polystyrene	6	$1,141,050			10,610

Ontario Ministry of the Environment

Waste Management Branch

The Industrial 4Rs Program

A Summary of Projects Supported as of May 31,1989

INDUSTRIAL 4Rs FUNDING PROGRAM
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Ontario Ministry of the Environment

Waste Management Branch

The Industrial 4Rs Program

A Summary of Projects Supported
as of May 31,1989

INDUSTRIAL 4Rs FUNDING PROGRAM
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Glass	Glass Collection	2	$30,700			3,025
Plastics	Nylon, Leather, PE, PVC, Polystyrene	6	$1,141,050			10,610

INDUSTRIAL 4Rs FUNDING PROGRAM cont.
CAPITAL PROJECTS (as of May 31, 1989)

TYPE OF PROJECT	MATERIALS DIVERTED	# of PROJECTS FUNDED	MOE FUNDING	ANTICIPATED WASTES DIVERTED PER ANNUM		
				HAZARDOUS		NON-HAZARDOUS
				(Tonnage)	(Litres)	(Tonnage)
Chemicals	Peroxide, Cyanurate Misc. Complex Chem.	4	$95,775		3,616,050	
Oils	Coolant/Hydraulic	5	$256,745		1,052,200	
Food	Dairy, Produce Bakery	1	$116,000			12,500
Process Sludge	Tar/Coke Brine Sludge - Hg	2	$65,000	900	61,300	
TOTALS		73	$5,611,516	16,940	10,231,350	264,575

TOTAL NON-HAZARDOUS SOLID WASTES DIVERTED:	264,575 Tonnes
TOTAL HAZARDOUS SOLID WASTES DIVERTED:	16,940 Tonnes
TOTAL LIQUID INDUSTRIAL WASTES DIVERTED:	10,231,350 Litres

INDUSTRIAL 4Rs FUNDING PROGRAM
TECHNOLOGY DEVELOPMENT and DEMONSTRATION PROJECTS (as of May 31, 1989)

TYPE OF PROJECT	EXAMPLES	# of PROJECTS	MOE FUNDING
Technology Development	Metal Recovery from Sludge Steel Dust Recycling Cheese Protein Recovery Kraft Mill Sludge Recycling Newspaper De-Inking Wastewater Phenol Recovery Latex Recovery	18	$428,450
Demonstration	Whey Protein Recovery Newspaper Reuse for Cement Corrugated Collection System Mobile Oil Reclamation Foundry Sands Recycling Tire Recycling Corrugated as Cattle Feed	13	$1,346,354
TOTALS:		31	$1,774,804

TOTAL INDUSTRIAL 4Rs PROJECTS FUNDED (May 31, 1989):	104
TOTAL INDUSTRIAL 4Rs FUNDING (May 31, 1989):	$7,386,320
CANADIAN WASTE MATERIALS EXCHANGE:	$250,000 over 10 years.
ONTARIO WASTE EXCHANGE:	$250,000 over 3 years.

BEYOND THE BLUE BOX

by

R. Flemington, President, Ontario
Multi-Material Recycling Inc.,
Toronto

Browsing through the program, I found the historical data with respect to this waste management conference very interesting.

And without wanting to take anything away from this splendid venue, I do harbour some regrets when I note that in the early years, the conference was held at locations such as Delawana Inn at Honey Harbour and Bigwin Inn on the Lake of Bays.

Of course, in the mid fifties, environmental issues did not appear nearly as critical. The visionaries on the Pollution Control Board of Ontario and the Ontario Water Resources Commission who organized those early conferences must have felt they needed to add a little inducement to boost attendance--or that environmental issues were somehow symbolized by the north.

"Environment" was not a word in common use when I was a teenager, going to high school in St. Catharines in 1954--the inaugural year for this conference. People who took anything to the dump on their own were pretty conscientious. Roadside ditches outside of towns and cities made convenient receptacles for all kinds of junk.

Paint, oil and other toxic liquid wastes just went in with regular garbage destined for incineration or landfill, or were simply poured down the sewer or into any handy body of natural water. Industrial effluents and wastes were only beginning to be recognized as potential problems and Sudbury looked like a moonscape.

Memories of the war and the depression which preceded it were fading. Everybody was working. The economy was booming. And nobody really thought much about waste management.

In that light, I guess I can understand Honey Harbour and the Lake of Bays.

Well, times have changed. That's not news to the people in this room. Neither--fortunately--is it to the man in the street. The Environmental Monitor, a private national public opinion service, released a report in April which shows that 58 per cent--or almost six out of 10--Canadians say they strongly favour passing a law making it mandatory for all households in their community to participate in recycling--even when most Canadians have no recycling service at their curb now.

And close to half of Canadians consider the amount of packaging material used for consumer products to be a very serious waste management problem in Canada today. It's not just the Environmental Monitor. Poll after poll in Canada, in North America, in Europe and in the industrialized countries around the world shows the same thing.

The environment is blue-pencilled on every agenda and the surveys show that environmental concern will be the global rallying point, probably for at least the next decade. The awareness that we must act--and act expeditiously--has been slow in coming but there is no question that it is now here--and with a vengeance.

One concern originally coalesced around the widely publicized garbage barge that left New York a couple of years ago, looking for a home in the Caribbean.

The barge centred our attention on the problems confronting New York, but New York is not alone. The problem is becoming ubiquitous to the developed world and here in Ontario we also face a growing problem with regard to waste disposal.

It is a problem that has escalated locally since 1967 when the decision was taken, here in Toronto, to phase out the incinerators which handled much of our garbage.

It is a problem which OMMRI, which I represent, is attempting to address.

OMMRI is a not-for-profit corporation created in 1986 by Ontario's soft drink industry, its container and container material suppliers to encourage and help fund the rollout of a province-wide municipal multi-material recycling network.

OMMRI members are committing $20 over four years--to 1990--to help municipalities buy capital equipment such as household recycling boxes--or "Blue Boxes" as they are called--special recycling trucks and processing equipment needed to implement curbside recycling programs.

And that's what I want to talk about today--recycling as a key waste management option-- "Beyond the Blue Box." I'll do that by telling you where we came from and where we are going. Then I'll look "beyond."

Recycling has been described as a way of "mining urban waste" to reclaim the basic materials in processed goods which we tend to throw away. Recycling is also a way to divert solid waste from overflowing dump sites, which are the visible sores bearing testimony to the declining health of our environment.

A couple of centuries ago, dumps degraded into rich soil and represented only a temporary use of land. Today, partly because of the use of toxic synthetics, garbage no longer degrades safely and landfill sites can never be used for other purposes.

And when we consider that point in relation to Ontario, where an acre and a half is being irrevocably consumed by garbage each day, it is easy to understand why the environment is such a hot issue.

Every year we send 10 million tons--one ton for every person in the province--to landfill and incineration. Ontario has an estimated 600 landfill sites, occupying 100,000 acres of land. The Environment Ministry calculates that up to 300 municipalities will require additional landfill capacity to the end of this century.

And all the while, the locals are screaming NIMBY--"Not in my back yard."

In order to cope in such an environment, Ontario is attempting to address the issue through the three "R"s--reduction, reuse and recycling. And it it the third of these options with which OMMRI is deeply involved.

What is Ontario's solid waste stream made up of? An analysis of all municipally-collected residential and commercial waste shows the following:

. 22 per cent is food waste
. nearly 21 per cent is various types of paper, excluding newsprint
. nearly 15 is newspapers
. 15 per cent is yard waste
. just over 5 per cent is cans
. 5 per cent is glass
. 5 per cent is plastic, rubber and leather
. 4 per cent is clothing and textiles
. 3 per cent is wood
. approximately 6 per cent is classfied as "other".

And it is interesting how public perception works. According to the Environmental Monitor poll I quoted earlier, 60 per cent of Canadians consider plastic to be primarily responsible for our waste problem. Yet plastic, rubber and leather combined total only 5 per cent of solid waste.

Only 4 per cent of the poll's respondents pointed to paper as the prime culprit. Yet newsprint and other paper combined account for 36 per cent--or more than a third--of residential and commercial waste.

Although soft drink containers comprise less than one per cent of the municipal solid waste stream, OMMRI decided to tackle the challenge of recycling head on, collecting food cans and jars and newspapers in addition to soft drink containers, in order to make the system truly "multi-material."

OMMRI works in a three-way partnership with the Ministry of the Environment and the municipalities in implementing municipal programs. Each partner contributes equally to start-up costs, which includes "Blue Boxes", collection trucks, and equipment for regional processing centres where materials are sorted, baled and prepared for market.

OMMRI also provides direct technical support and underwrites promotion and public relations activities when programs are launched.

It has worked extremely well.

In 1986, when OMMRI was launched, about 150,000 Ontario householders were already involved in recycling programs. By the end of '87, when OMMRI had been active for a year, 404,000 single family households were participating, a number which had grown to 1.3 million by the end of 1988. The millionth household received its "Blue Box" in November of 1988.

The number is now over 1.5 million and will reach two million early in 1990.

A conservative estimate of the resulting yearly waste diversion is 224,000 tons, or 13.7 per cent of the waste generated by participating households, and we believe that number could go to more than 15 per cent.

That means that when the program is fully in place with the two million single family households in Ontario, 320,000 tons of waste per year will be diverted.

Recycling has been described as a way of "mining urban waste" to reclaim the basic materials in processed goods which we tend to throw away. Recycling is also a way to divert solid waste from overflowing dump sites, which are the visible sores bearing testimony to the declining health of our environment.

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That means that when the program is fully in place with the two million single family households in Ontario, 320,000 tons of waste per year will be diverted.

Pilot studies to include apartments indicate that another 77,000 tons per year could be added by servicing 720,000 apartment units. Another 33,000 tons could be collected by servicing, through drop-off depots, 400,000 rural residences located in remote but reachable areas.

This totals 430,000 tons--or 4.3 per cent of the 10 million tons landfilled yearly. And while 430,000 tons sounds--and is--impressive, it represents only a small step in achieving the provincial goals of recycling 25 per cent of solid waste by 1992 and 50 per cent by the year 2000.

When OMMRI's commitment runs its course next year, we will have helped to establish a network that involves two million single family homes, 137,000 apartment units, 174 rural depots and 37 regional processing centres located strategically throughout the province.

In the long term, however, industry's most significant involvement may prove to be in the establishment of markets for the recycled containers.

Using post-consumer materials in the manufacturing process is known as "closing the loop" and OMMRI's members from the container supply industries are individually committed to providing a market for their material.

Recycled steel and aluminum, when mixed with virgin metals, can be used to make new cans. Glass bottles and jars are crushed to make cullet which is used in the manufacture of new bottles and jars. Polyethylene terephthalate plastic, used in PET bottles, when ground down, can be manufactured into a wide range of new products such as fibrefill for ski jackets and automobile bumpers and dashboards.

It's a self-perpetuating circle. Manufacturers will utilize recycled materials because there is an assured supply. Recyclers can collect and sell them, because there is an assured market.

One of the things learned on a recent study trip to Europe, from which I returned earlier this month, is that markets have been established there for secondary materials--particularly paper--with many foreign materials mixed in.

The Europeans seem to have developed the ability and technology to make use of heavily contaminated recycled materials. We don't have the infrastructure or manufacturing base at this point to assimilate such materials. But, inevitably, the time fill come when we have to deal with larger volumes and lower qualities of waste. Equally inevitably, Ontario industries will rise to that challenge by making the necessary investments.

The newspaper and newsprint industries are not members of OMMRI. There is currently a problem because a limited domestic market for recycled newsprint is making it necessary to export 50,000 tons of used newspapers at a time when there is a glut on the world market.

It is estimated that 10 million tons of plastic waste are generated annually in North America. Currently, a number of municipalities are retrofitting their "Blue Box" systems to include mixed plastic. More will follow suit, and as they do, an assured supply of mixed plastics will be generated. Already several industries are competing to build mixed plastic recycling plants to utilize this material supply.

This is only one of the solutions to maximize the potential of the blue boxes. Others are to be found in added waste management practices such as kitchen and yard waste composting. Add to this efforts to reuse and reduce waste, and programs aimed at industrial waste reduction, and we begin to realize the potential of a strategy encompassing all sectors of society.

Environment Minister Jim Bradley has said on numerous occasions that other industry segments, including plastics, newspapers, grocery products manufacturers and distributors and retailers should be brought aboard. And in this regard, he has been encouraging OMMRI to expand its membership.

He has also confirmed that he will introduce legislation to clarify the province's power to make recycling mandatory. At the same time, he expressed confidence that individual industries would (quote) "take responsibility for the environmental fate of their products" (end quote).

I think our environment minister is a pragmatist. He's from Missouri, and his attitude is "show me."

But I think his confidence that Ontario's industries will assume responsibility is not misplaced. I think they are going to show him, and I base this on recent discussions with the associations representing other industries with a stake in the recycling issue.

I am very happy to be able to report today positive consensus among a broad spectrum of industries seems to be building.

The attainment of the Minister's goal of 25 per cent waste reduction by 1992, and 50 per cent by 2000 may seem improbable in light of the resources dedicated to the task at this moment.

Right now, one industry segment which contributes less than 1 per cent of the total waste is able to divert 13.7 per cent of total household waste. It is able to divert 4.3 per cent of the total solid waste which is landfilled. Ask yourself: What is possible when the others join the game?

In truth, industry's role is critical to the future of waste reduction and management in this province. Because the solutions to the waste problems we've created here in Ontario will also have to be found here in Ontario.

This became manifestly clear during the trip to Europe I mentioned earlier. The tour provided an opportunity for municipal politicians, works department staff, industry representatives and consultants to observe recycling activities in Europe.

And let me tell you that there are no magic solutions which we can import. Yes, quite a number of jurisdictions are successfully recycling, but on a small scale compared to what has been established here in Ontario over the past three years.

Moreover, the European experience is largely in small communities. It will take a good deal of clear-headed planning to consider it in the greater Toronto area, because of Metro's high population densities and industrial concentration.

And it will be the companies that comprise that industrial concentration in Toronto and throughout the province--far sighted industries, able to break new ground--which will build on the foundations which OMMRI has already established.

Industries which develop the means to make their products recyclable.

Industries committed to designing their products with their ultimate disposal in mind.

Industries that will close the loop by establishing post-consumer markets for their products.

Industries willing to go a step beyond current practices.

While Ontario is currently a world leader in the establishment and maintenance of a curbside multi-material recyling network, this is only a first step in moving from a throwaway to a conserver society.

It is not enough...not if we stop here.

A wise man once said that it is not enough just to be on the right road. If you are standing still, you'll be run over.

It is time to think about mining the remaining mountains of urban waste.

Thank you.

OMMRI

Ontario Multi-Material Recycling Incorporated
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PO Box 20
Toronto, Ontario M5H 3R3
(416) 340-9770 Fax 340-9771

Harold Corrigan - Chairman
Robert A. Flemington - President

Information Sheet
Ontario Multi-Material Recycling Incorporated (OMMRI)

Ontario Multi-Material Recycling Incorporated (OMMRI) is a not-for-profit corporation established by Ontario's soft drink industry, and its container and container material suppliers to foster and fund the implementation of municipal multi-material curbside recycling programs in municipalities throughout Ontario.

Created in 1986, OMMRI is committed to helping develop a recycling network that will enable Ontarians to participate in municipal recycling programs, and thus help reduce the amount of household solid waste going into landfill sites.

To enable OMMRI to work toward its goal, industry members are providing $20 million over four years, 1987-1990, to assist municipalities finance their programs. OMMRI contributes toward the costs of collection and processing equipment, and the plastic "Blue Boxes" which are used by householders to collect recyclable materials. OMMRI also pays appropriate costs of publicizing the launch of municipal recycling programs

Recyclable materials which are collected in the blue boxes are glass bottles and jars, steel and aluminum food and beverage containers, plastic soft drink bottles which are called "PET" containers and newspapers. The boxes filled with these materials are placed by the householder at the curbside for pickup by special recycling trucks on a regular garbage collection day.

In rural communities, where curbside pickup is not practical, OMMRI is working closely with these communities to develop and implement programs so that rural residents have the opportunity to recycle. The cost of implementing the recycling of solid waste from high rise buildings and commercial establishments is also shared by OMMRI.

recycled paper

"Blue Boxes" have become the symbol of recycling across Ontario as the momentum to implement recycling programs continues to grow. By the end of 1988 over 1.2 million households in the province were served by Blue Box programs, up from 161,700 households at the end of 1986. That number is expected to climb past 1.9 million households by the end of 1989. When the municipal network is fully implemented in Ontario, it is estimated that 242,600 tons of recyclable materials will be recovered annually from household solid waste.

In encouraging recycling and undertaking its work, OMMRI closely cooperates with Ontario's Ministry of the Environment, municipalities, private industry and non-government environmental organizations.

OMMRI members are:

A&W Food Services of Canada Ltd.
Alcan Rolled Products Company
Ball Packaging Products Canada Inc.
Cadbury Schweppes Canada Inc.
Canada Dry
Coca-Cola Ltd.
Continental Can Canada Inc.
Consumers Packaging Inc.
Crown Cork & Seal Canada Inc.
Crush Canada Inc.
Dofasco Inc.
Domglas Inc.
Laidlaw Waste Systems Ltd.
Ontario Soft Drink Association
Orangeville Bottling Company Ltd.
Pepsi Cola/Seven Up Bottling of Toronto
Pepsi-Cola Canada Ltd.
Retail Council of Canada
Seven-Up Canada Inc.
Stelco Inc.
Twinpak Inc.

ONTARIO CLASS 1 HOUSEHOLDS . . .

	1,986,160	**TOTAL PLANNED & LAUNCHING**	
	25,000	SAULT STE MARIE	Feb-90
	77,000	LONDON	Feb-89
	30,000	HALDIMAND-NORFOLK	Nov-89
	20,000	VAUGHN	Nov-89
	15,600	CORNWALL	Oct-89
	5,000	KING TWP	Oct-89
	16,200	NORTH BAY	Oct-89
	45,000	SUDBURY	Oct-89
	1,000	WEST NISSOURI	Oct-89
	1,400	LONDON TWP	Oct-89
	1,200	LOBO TWP	Oct-89
	25,600	BRANTFORD	Sep-89
	1,600	SOUTH DUMFRIES TWP	Sep-89
	1,000	SHELBURNE	Sep-89
	3,400	NORWICH	Sep-89
	6,600	AURORA	Sep-89
	1,000	BOSANQUET	Sep-89
	3,000	FORT FRANCES	Sep-89
	3,500	KENORA	Sep-89
	5,500	OSGOODE et al	Sep-89
	2,200	MCNAB	Sep-89
	450	MILDMAY	Sep-89
	2,700	PARIS	Sep-89
	2,100	EAST-ZORRA TAVISTOCK	Sep-89
	15,000	NEWMARKET	Sep-89
	2,800	WAINFLEET	Sep-89
	37,400	THUNDER BAY	Sep-89
	1,200	MITCHELL	Aug-89
	3,100	ERNESTOWN	Aug-89
	2,000	PITTSBURGH TWP	Aug-89
	13,000	CITY OF KINGSTON	Aug-89
	13,000	TWP KINGSTON	Aug-89
	19,300	ESSEX-WINDSOR (PHASE 3)	Jul-89
	1,000	SIOUX LOOKOUT	Jul-89
	800	IGNACE	Jul-89
	800	HOPE TWP	Jun-89
	7,000	MUSKOKA LAKES	Jun-89
	1,400	PUSLINCH	Jun-89
	2,900	WILMOT	Jun-89
	111,000	SCARBOROUGH	Jun-89
	5,600	GREY TWP et al	Jun-89
	5,000	ORANGEVILLE	Jun-89
31 May, 1989	1,448,210	**TOTAL LAUNCHED**	
	83,450	ESSEX-WINDSOR (PHASE 1+ 2)	
	5,650	OXFORD COUNTY	
	12,250	PERTH COUNTY	
	1,900	HURON COUNTY	
	3,200	BRUCE COUNTY	
	8,700	GREY COUNTY	
	118,400	NIAGARA REGION	
	109,860	HAMILTON-WENTWORTH REGION	
	75,100	WATERLOO REGION	
	35,600	WELLINGTON COUNTY	
	70,100	HALTON REGION	
	151,800	PEEL REGION	
	336,300	METRO TORONTO	
	90,000	DURHAM REGION	
	11,600	NORTHUMBERLAND COUNTY	
	81,500	YORK REGION	
	5,000	LINDSAY	
	21,500	PETERBOROUGH	
	41,400	SOUTH SIMCOE	
	23,900	NORTH SIMCOE	
	10,800	MUSKOKA/HALIBURTON COUNTY	
	6,400	BROCKVILLE	
	140,100	OTTAWA-CARLETON	
	700	STORMONT,DUNDAS,GLENGARRY	
	3,000	DRYDEN	

THE RECYCLING OF REFRIGERANT CHLOROFLUOROCARBONS

by

Warren J. Heeley, President, Heating, Refrigerating
and Air Conditioning Institute of Canada, Etobicoke,
Ontario

The Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI) is a national nonprofit trade association representing manufacturers, wholesalers and contractors who supply, install and service refrigeration, heat pumps and air conditioning products in Canada. HRAI members are Canada's largest users of chlorofluorcarbons in the form of refrigerants and as such, are major stakeholders in the issue concerning the effects of chlorofluorocarbon (CFC) emissions on the stratospheric ozone layer and increases in global temperatures known at the greenhouse effect. The HVACR industry represents over $4 billion in sales annually and employs over 20,000 Canadians, many in family-owned businesses scattered throughout the country.

Our industry welcomes the opportunity to participate in the Ontario Waste Management Conference and discuss the issue of recycling of chlorofluorocarbon refrigerants as it applies to the commercial refrigeration and air conditioning industry. Through HRAI, the refrigeration and air conditioning industry has been involved in discussions with the federal and provincial environment ministries as well as related user groups for over two years in an effort to find responsible solutions to this serious environmental concern.

HRAI has a unique structure in that the association represents manufacturers, wholesalers and contractors. From the outset of this presentation, I would like to make it clear that all three segments of our industry are committed to getting out of CFC use as soon as possible. However, our industry is faced with few opportunities for alternatives or substitution for existing equipment until such time as non-CFC refrigerants are commercially available in the next few years.

For this reason, the refrigeration and air conditioning industry views the concept of refrigerant recycling as an important step to expedite the reduction of usage of the controlled CFC's and at the same time, ensure there is adequate supply from the declining production of these CFC's to meet the needs of existing equipment owners.

My presentation today will focus on the following areas of the CFC issue:

a) the usage of the controlled CFC's in the industry
b) industry steps to reduce CFC usage, and
c) the opportunities/barriers to recycling CFC's

a) Usage of CFC's in the Canadian Refrigeration and Air Conditioning

I would like to clarify from the outset that in this presentation, we are addressing commercial refrigeration and air conditioning and the term "refrigeration" means "commercial refrigeration " which includes refrigeration in supermarkets, food storage facilities, ice rinks, etc. In addition, residential air conditioning is not included because it employs HCFC-22 which is not a controlled refrigerant.

The following outlines the present applications where CFC-11, 12, 113, 114 and 115 are used in the HVACR industry:

CFC-11	large office tower air conditioning (centrifugal systems) commercial air conditioning systems solvents for flushing refrigeration systems
CFC-12	commercial refrigeration (food processing, preservation, storage and display, medical research and storage) built-up air conditioning systems (service) dehumidification systems solvents for flushing refrigeration systems
CFC-113	commercial air conditioning systems large office tower air conditioning (centrifugal systems)
CFC-114	limited use in large office tower air conditioning (centrifugal systems)
CFC-115*	low temperature and commercial refrigeration (mainstay of supermarket equipment) heat pumps * as a component part of CFC-502

It is important to note in looking at the use of the controlled CFC's in our industry that 80-90% of the usage volume on an annual basis is in the after-market or commercial service segment. We have also estimated that there are at least 10,000,000 units presently in the field using the above refrigerants on a national basis.

A major issue in our industry's deliberations over how to achieve CFC reduction was essentiality and HRAI recently formed a task group of industry experts to access the issue of essential versus non-essential uses. By doing this, we could readily identify the opportunities for reduction of usage. The task group quickly came to the realization that CFC's when used as refrigerants in refrigeration and air conditioning systems, have a substantial effect on the life-style of the Canadian people. In particular, the food chain, health services, comfort conditioning of the indoor environment and other interrelated industries depend on these refrigerants when providing their products and services to the public.

Refrigerants have had a considerable effect on the improvement of life-style of every Canadian citizen and for most of the existing uses, as stated in my opening remarks, there are at present no commercially available or acceptable alternatives to CFC's. Once alternate non-CFC refrigerants such as HFC-134a are introduced, new equipment can be designed to eliminate use of the controlled CFC's. Our industry's biggest challenge, however will be to deal with the existing stock of equipment that use the controlled CFC's and ensure that this equipment can be serviced safely until substitute non-CFC refrigerants are commercially available.

b) Industry Steps to Reduce CFC usage

HRAI feels that the key to significant reduction of CFC usage lies in the after-market and more specifically, the service sector of the industry. The typical refrigeration and air conditioning serviceman in the field has had little awareness of the issue and the challenge for our association has been to raise awareness and offer a practical approach to re-orienting day-to-day use and handling of the controlled CFC's.

In July of 1988, HRAI initiated a programme to reduce the impact of CFC usage on the environment through distribution of the "HRAI Action Guideline for Reduction of Use of Controlled CFC's". The objective of the guideline is to change the attitudes of designers, architects, engineers, installers and serviceman towards CFC's. The guideline was circulated to HRAI's 1500 reader mailing list (which includes over 1100 contractor members) and to related industry and professional associations for endorsement and communication to their memberships. Those groups included the Refrigeration Service Engineers Society of Canada, the Canadian Region of the American Society of Heating Refrigerating and Air Conditioning Engineers, the Canadian Consulting Engineers Association and the Canadian Institute of Public Real Estate Companies.

In addition to communication through industry groups, HRAI worked with Heating-Plumbing Air Conditioning magazine (our industry's major trade press in Canada published by Southam) to include a special editorial and insert on the guideline in the September issue of the magazine. Through this vehicle, we were able to touch over 24,000 industry readers including 8,000 in the french language. Along with communicating the actual guideline, we urged the industry to use the RDA strategy (Read, Discuss and Act). This strategy involved thoroughly reading the guideline, discussing it with employees in their respective companies and most important, beginning to act on the guideline recommendations.

The Action Guideline itself, contained the following recommended steps for the service sector to reduce the use of the controlled CFC's

1. **DO NOT USE CFC-11 OR 113 FOR FLUSHING**

   The use of CFC-11 and 113 in the flushing of refrigeration and air conditioning systems should be replaced by alternate cleaning methods such as the filter-drier or other available methods.

2. **USE RECEIVERS DURING SERVICING OF SYSTEMS**

   All refrigeration and air conditioning systems should be pumped-down and contained in a receiving vessel (whether part of the system or separate) so that no refrigerant is vented to atmosphere.

3. **REPLACE CFC-12 WITH ENVIRONMENTALLY SAFER REFRIGERANTS WHERE FEASIBLE**

   When servicing CFC-12 refrigeration and air conditioning systems, replacement of CFC-12 with environmentally safer refrigerants should be considered where it is practical and recommended by the equipment manufacturer.

4. **PRESSURE TEST WITH INERT GASES AND ENSURE ALL SYSTEM PIPING IS TIGHT**

   Pressure testing of refrigeration and air conditioning systems should not be done with CFC-12 and instead, other available environmentally safe alternates must be used.

5. **DO NOT USE 1 POUND CANS OF REFRIGERANT**

   The use of 1 pound refrigerant containers shall be eliminated because of the high percentage of refrigerant loss from the container.

6. **REUSE, RECOVER AND RECYCLE REFRIGERANTS, WHERE POSSIBLE**

   Where of acceptable quality, refrigerant should be reused in every case. Where refrigerant is not of an acceptable quality for immediate reuse, then recovery and recycle methods should be carried out, where possible.

c) Opportunities/Barriers to Recycling Refrigerant CFC's

The "Three R's" strategy (as its called) of reuse, recovery and recycling of refrigerants is at present only beginning to take shape despite the industry's resolve to promote and support its concepts. In practical terms, this strategy requires that service personnel minimize loss of refrigerant during service work through the use of receiving vessels and isolation valves as well as determine the opportunities for reuse of the existing refrigerant and/or withdrawal for recycling purposes.

It is important to point out the opportunities presented by the refrigeration cycle itself. The principle of operation for refrigeration and air conditioning systems is a closed-loop cycle that is designed to have no refrigerant loss during its operation. Though there may be loss during the life of a piece of equipment, the closed-loop design quite naturally fits in with the strategy of recovery, recycle and reuse.

Historically, industry service personnel have practiced refrigerant reuse in large commercial systems simply because of the cost associated with refrigerant replacement. The most common system breakdowns occur because of motor burnouts or compressor failures. In many of these cases by installing a filter/dryer in the system, the remaining refrigerant is retained and cleaned up as the repaired system continues to operate.

The opportunities for recycling lie primarily with breakdowns where contamination of the refrigerant makes it unacceptable for reuse or during disposal of equipment. In simplistic terms when this opportunity arises, the refrigeration mechanic would remove the refrigerant from the equipment into a container and transport it to a recycling location. However, our industry has quickly discovered that this process is far from simple and there are a number of issues that must be resolved to ensure recycling becomes the norm for service personnel.

Firstly, our contractor members are telling us that compliance will only come if recycling is easy to do. A minimum quantity of refrigerant in a system should be established as a guideline for recycling by service personnel. Though some interest groups have advocated recycling ALL quantities, there is a practicality issue that enters into this debate which will influence the industry's performance. Our preliminary thoughts are that recycling should be required on systems with 5 pounds or more of refrigerant.

Hardware issues are also unresolved at this point. The industry has yet to find a pump which can remove refrigerant in a reasonable period time and at the same time, be lightweight and portable to permit use by service personnel. The typical locations for refrigeration and air conditioning systems (rooftops, machine rooms, etc.) do not lend themselves to the large, awkward pumps that are presently available. As well, there is the need to provide a suitable refrigerant recovery cylinder that could be used in the field. The Air Conditioning and Refrigeration Institute (ARI), our counterpart in the United States, has established a subcommittee to look at specifications for such a cylinder and their report is anticipated in the fall.

The largest issue however, for our industry to resolve centers around the designation of used or spent refrigerant. At present in the province of Ontario and in other jurisdictions of Canada and the United States, used refrigerant is classified as a hazardous waste and is subject to control provisions listed in the respective hazardous waste legislation. To date in this province, this designation has prevented any appreciable progress in the development of a recycling infrastructure. Since early in 1989, HRAI has been working with the Ontario Ministry of the Environment to put in place the necessary exemptions under the province's hazardous waste act which would permit the industry to practice recycling techniques. This work is consistent with the proposed regulations for Ontario Bill 218 (amendments to the Environmental Protection Act) which presently call for the establishment of a recycling infrastructure by December 31, 1989.

It is our industry's position that the present direction being taken towards exemptions under the hazardous waste act will NOT ultimately meet the objective of establishing the required infrastructure. Instead, we feel the more beneficial route will be to classify used refrigerant as a recyclable material. This same debate over classification has been going on in the United States for some time and on May 19, 1989, the U.S. Environmental Protection Agency reaffirmed its decision NOT to classify used refrigerants and used refrigerant oil as hazardous waste under the authority of the Resource Conservation and Recovery Act. The EPA's decision was based on the fact that a hazardous label would greatly hinder efforts to recycle CFC refrigerants. In the U.S. as in Canada, recycling is seen as a necessary step to continue some refrigeration and air conditioning applications until CFC substitutes are available. This EPA decision was requested by the US industry as guidance to states who are free to make their own hazardous waste designations.

The challenge for both industry and government in regards to recycling of CFC refrigerants is to make the system as simple as possible for the mechanic who is servicing the refrigeration and air conditioning equipment. These service personnel work independently and are essentially the "decision-makers" as to whether recycling techniques will be embraced or ignored. A system wrought with regulatory barriers will no doubt breed complacency. A simple system with a minimal "red tape" should have the net effect of encouraging refrigeration mechanics to handle CFC refrigerants in an environmentally sound manner and thus meet the objectives of both the industry and the government.

USED OIL RECYCLING

by

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Safety-Kleen Canada Inc., Breslau, Ontario

ABSTRACT

Used lubricating oil is a natural resource which can be recycled in many different ways. Reclamation of industrial oils, reprocessing to yield clean fuels, and re-refining to generate high quality lube oil basestocks can all be used beneficially. Impediments, such as planned blending with hazardous waste streams, complex formulations, and poor economics must be considered when selecting the most appropriate approach. We believe that together the generator, the recycler, and the customer using recycled products can contribute to a positive solution for a potentially major environmental problem.

INTRODUCTION

Used lubricating oil recycling is not a new subject. Throughout this century, entrepreneurs have "discovered" the resource represented by lubricants drained out of crankcases, machinery, and sumps. A wide variety of uses have been marketed. It could be said that used oil recycling was one of the earliest attempts at waste minimization and resource recovery.

Recycling of this commodity is possible because the typical uses of the virgin product do not chemically change the primary compounds making up the lubricant. The statement often heard is that "lube oil does not wear out, it just gets dirty." Research around the world has confirmed this. In addition to picking up dirt, water, and other extraneous materials, lube oils age due to the depletion of additives that provide many of the properties in which we are interested. These include corrosion resistance and minimal viscosity change over wide temperature ranges.

IMPEDIMENTS

So why has the industry not flurished? Why are a vast majority of used oil recyclers no longer in business? There are several reasons, among which are: a) environmental problems, b) feedstock competition, c) lube formulation complexity, and d) petroleum economics.

Environmental Problems - Inspite of its value as a resource, used oil is still a waste stream to most generators. As such, it often is mixed with other wastes before disposal. This is inadvertently encouraged by the fact that used oil is less expensive to dispose of than many waste streams, especially those considered to be hazardous. In fact, during times of higher crude oil prices, collectors often paid generators for their used oil. It did not take generators long to figure out where to hide their other wastes, since it simply increased the volume of used oil for which they were paid by volume.

It is not unusual to find several thousand parts per million of halogenated solvents in used oil coming into a recycling facility. While there are a few additives in lubricants that might explain a small part of these, most detailed analyses show that the halogens are solvents that have been added after the fact.

Because of this frequent adulteration, some of the natural constituents (such as benzene) found in lube oils, and contaminants introduced during use (such as lead), many environmental agencies have declared used oil to be a hazardous waste. The U.S. Environmental Protection Agency is still considering what to do, not because they disagree with the above points, but because they want to do everything possible to encourage recycling.

The problem with weak regulations is that the volumes of used oil generated each year (well over 1 billion gallons in North America) posses a significant threat to the environment if improper disposal occurs for even a relatively small portion of this material. Several abandoned used oil collection/processing sites in the U.S. are currently being cleaned up under Superfund authorization due to contamination of drinking water supplies and other very serious impacts.

The costs of recycling used oil properly from an environmental standpoint can be high for an operator with small volumes. Analyzing oil to determine what contaminants are in the feedstock and products to determine whether it is safe to market requires expensive instrumentation. Thus, many of the small operators have gone out of business because they could not increase their volumes collected sufficiently to cover such costs. Others have tried to continue to operate without knowing the composition of what they were selling. The fines, litigation, and loss of business due to an increasingly aware public have forced them out. Given the threat posed by marketing of this material without analyses, these closure are probably reasonable.

Feedstock Competition - There are many potential uses for used lubricating oil. While some of the more humorous ones (application to the skin of pigs to keep them soft) tend to involve very small volumes, there is serious competition for the large volume generator business. The primary pathway has always been to burn the oil as a fuel. This can be done with raw used oil (such as in cement kilns), with fuel oil/used oil blends, or with reprocessed used oil, which has been cleaned up to meet burner and environmental specifications. The price and availability of competing products, such as #4 fuel oil and lubricating oil basestocks, often determine the relative advantages of the competing markets.

Alternative applications like road oiling and mining dust suppression have been largely eliminated due to the ramifications of applying this waste stream directly to the environment. An entire town in Missouri (Times Beach) had to be purchased by the U. S. EPA due to contamination carried by used oil applied on roads and farm areas.

Once again, the smaller the business, the less able it was to survive the competitive pressures. Larger businesses could be more flexible, while also usually having more financial strength to survive short-term changes in the market.

Lube Formulation Complexity - On top of everything else, the manufacturers of virgin lubricants have been working for decades with the additive suppliers to develop better oils that would last longer and perform better. Such resiliency also made oils much more difficult to recycle. Thus, simple processes did not clean up the oil sufficiently and more expensive methods, similar to what crude oil refiners use to generate lubricants in the first place, were required. Once again, the small operations could not afford such capital outlays.

Petroleum Economics - As mentioned above, competition has always been a factor in this business as in all others. However, the used oil recycler is in a somewhat unique position in that both his feedstock prices and product prices are largely controlled by the same competitor. The major oil companies sell the fuels that tend to establish the value of used oil, and they also sell the higher quality lube oil basestocks that compete with the recycled products. When the total petroleum market declines as it has in the past several years, the margin between those levels shrinks, and the recycler is left with no profits.

TECHNOLOGY

There has been a considerable amount of research completed relative to used oil in the past two decades. A recent literature review found 1200 directly related references during just a portion of that period. This involves both the processing and the analytical requirements.

Reprocessing - The production of a specification fuel from used oil is normally referred to as reprocessing. This usually involves simple settling, filtration, and evaporation of water and low boiling-point contaminants (e.g., gasoline and solvents). The U.S. EPA has established specifications for this type of fuel when marketed to nonindustrial boilers, such as apartment buildings. The analytical requirements include PCB's, flash point, halogens, and selected metals.

Reclaiming - Many industrial lubricants can be recycled with minimal clean-up. Sometimes this is done with in-house equipment at larger facilities. The technology is often very similar to reprocessing, except that the segregated material is rejuvenated for its original use. For example, a used hydraulic oil is reclaimed to meet virgin hydraulic oil specifications. The analytical requirements are dictated by each client, but usually include halogens, flash point, and total ash.

Re-refining - The most advanced of the used oil recycling approaches is the re-refining of the resource into a lubricant basestock. While many techniques have been proposed, only a few have been commercialized. For many decades, completion of the oxidation of the oil using concentrated sulfuric acid was followed by clay adsorption and filtration to clean up any degraded components. However, that process has odor problems and generates an acidic sludge by-product which is difficult to deal with in today's regulatory environment. Further, this process is not satisfactory for many of the more complex formulations described above.

Thus, most of the industry moved to a vacuum distillation step of some sort. The water and low-boiling hydrocarbons are flashed off at atmospheric pressure, then the lube oil is vacuum distilled in one or two steps. In the initial installations, the re-condensed lube oil was treated with activated clay. However, one now has the oily clay to dispose of, and product quality was not always what it could be.

Currently, the favored technology is to vacuum distill using thin film evaporators and polish the product using hydrofinishing. This involves passing the distillate in the presence of high pressure hydrogen over a catalyst bed held at high temperature. This removes sulfur, nitrogen, and oxygen from the oil while stabilizing it toward color and odor formation. It is the same finishing step that many virgin lube oil manufacturers use. In fact, the product of this type of re-refining is indistinguishable from virgin lube oil basestock when "fingerprinted" using an infra-red spectrometer.

These basestocks are used for blending into such products as motor oils, hydraulic oils, gear oils and A.T.F.'s. Finished oils are rigorously tested. For instance, motor oils are subjected to engine sequence protocols and must be approved to receive API ratings. Table 1 presents results for some of those tests using a re-refined oil from our Breslau Facility.

In addition to improved product quality, the distillation/hydrofinishing process produces no difficult by-products. The low boiling fraction can be used to fuel the plant, the vacuum distillation bottoms can be sold as an asphalt extender, and the water can be sent through the water treatment facility and discharged. The finishing step itself produces no recoverable by-products, as opposed to the sludges and oily clays of earlier technologies.

Recycled Oil Markets - As with most products, the marketability is directly related to the quality. Thus, reprocessed fuel, reclaimed industrial oils, and re-refined lube oils that meet or exceed normal virgin product specifications have little trouble with acceptance. There usually is a small discount to make them even more attractive. That combination of quality and economics results in a demand that at times exceeds supply. However, keep in mind that this industry has historically been made up of small businesses that can no longer survive, so there is a need to take advantage of this demand to expand as rapidly as possible.

TABLE 1

The following major engine test data on Breslube's SAE Grade 10W-30 motor oil meets the requirements of API SG/CC. The 10W-30 oil formulation includes Breslube's hydrotreated base oils, performance package and viscosity improvers.

	Test Results	API SG/CC Limits
Caterpillar 1H2		
Top Groove Filling, %	10	45 max
Weighted Total Demerits	31.0	140 max
CRC L-38		
Bearing Weight Loss, mg	21.8	40 max
Piston Skirt Varnish	9.6	9.0 min
10-Hour Stripped Viscosity @ 100°C, cSt	10.0	9.3-12.5
Sequence VE		
Average Engine Sludge	9.3	9.0 min
Cam Cover Sludge	8.7	7.0 min
Average Engine Varnish	5.9	5.0 min
Average Piston Skirt Varnish	6.5	6.5 min
Cam Lobe Wear, mils		
Maximum	7.6	15.0 max
Average	5.0	5.0 max
Sequence IID		
Average Engine Rust	8.7	8.5 min
Number Stuck Lifters	None	None
Sequence IIIE		
Average Engine Sludge	9.7	9.2 min
Average Piston Skirt Varnish	9.0	8.9 min
Oil Ring Land Deposits	4.2	3.5 min
Cam plus Lifter Wear, in		
Maximum	0.0009	0.0025 max
Average	0.0006	0.0012 max
Viscosity Increase @ 40°C @ 64 Hours, %	201	375 max

Results indicate control of engine deposits and oxidation while providing protection against rust, corrosion and wear.

The economics of re-refining, the most complex of the used oil recycling scenarios, involves a number of factors. Collection and transportation of huge volumes of used oil becomes a very important issue. A few million gallons a year will not suffice, but hauling oil for long distances can be very costly. The choice of proven technology is critical. Finally, marketing of large volumes of re-refined oil requires an aggressive and competent marketing organization, something the old mom-and-pop oil recyclers would never have dreamed of having.

CONCLUSION

Like many environmental problems, when the disposal of used oils is viewed from a recycling angle it becomes a win-win situation. The parties needing to dispose of the waste can be assured of an environmentally sound use of this resource if they make sure the recycler is carefully analyzing the wastes and any marketed products. The recycler contribute to the conservation of resources. The customers using the recycled products obtain a quality product at prices often below that of virgin materials. It is a solution we believe can serve us all well as we enter the twenty-first century.

COMMERCIAL/INDUSTRIAL SOLID WASTE REDUCTION PROGRAM FOR THE MUNICIPALITY OF METROPOLITAN TORONTO

by
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The Municipality of Metropolitan Toronto is dependent on its many commercial businesses and industries. Yet while companies in the area contribute to our economic growth, they also generate massive quantities of solid waste. In fact, the private sector is responsible for generating more than half of the 3.25 million tonnes of solid waste disposed of at Metropolitan facilities each year.

In recent years, the quantity of solid waste handled by Metropolitan Toronto has increased substantially. Over the period from 1983 to 1986, the quantity of waste received by Metro Toronto increased from 1.8 to 2.9 million tonnes annually. This dramatic increase can be attributed to a number of factors including the closure of other landfill sites and growth and development in the area.

Like many other urban centres, Metropolitan Toronto is facing a severe shortage of landfill capacity. Identifying and developing new landfill sites is a difficult, time-consuming and expensive process. In order to conserve our remaining landfill space, and to minimize the need for future landfills, programs are being implemented for waste reduction, re-use and recycling. Through these programs and increased landfill tipping fees, Metropolitan Toronto is working to meet the Provincial goal of 25 per cent. waste reduction by the year 1992.

In 1988, the quantity of solid waste received at Metro facilities remained at approximately the same level as 1987. This leveling off effect coincides with the implementation of several recycling programs and a major increase in landfill tipping fees for waste generated by the private sector. On May 1, 1988, rates increased from $18.07 to $50.00 per tonne at landfills and from $31.58 to $64.94 per tonne at transfer stations.

On May 1, 1989, the tipping fees increased further to $83.33 per tonne at the landfills and $100.00 per tonne at transfer stations. The full impact of this increase has not been realized, as it takes time for the haulers to pass the costs on to the generators. Private business also requires additional time to react by implementing waste reduction measures and recycling programs. Over the period from January 1 to March 31 of this year, the waste received at Metropolitan Toronto facilities had decreased by approximately 6 per cent over the same period last year.

In the past, many companies considered waste as a low priority item in their business planning. The Municipality of Metropolitan Toronto has undertaken a number of initiatives to help businesses to reduce and recycle their solid waste. These initiatives focus on providing industry with information and technical support to undertake recycling programs and establish policies aimed at waste minimization.

One of the barriers to recycling which is commonly cited by industry is the difficulty in locating markets for their recyclable materials. In order to assist companies, Metropolitan Toronto has produced a Recycling Market Directory. The Directory was prepared through discussions with secondary material dealers and end-use markets.

Generators of recyclable materials are advised to contact the markets for further information and to make arrangements for collection. The directory is available to any company in Metropolitan Toronto, free of charge. The markets/categories listed in the directory include:

- Asphalt, Concrete and Clean Fill
- Drums
- Food and Organic Waste
- Glass
- Metal Recovery
- Miscellaneous Material
- Plastic and Rubber
- Social Services Organizations
- Textiles
- Waste Paper
- Wood

Metropolitan Toronto also has a number of Recycling Advisors that work directly with waste generators to help companies develop programs. These staff members conduct solid waste audits of plants and offices. During site inspections, the Recycling Advisors assist companies in developing methods for waste reduction and recycling. In many cases, businesses are simply not aware of the opportunities available or alternative methods of handling solid waste.

Given the number of businesses in Metropolitan Toronto, it is important that we start by targeting materials that can be easily recovered from the waste stream. One way in which this is accomplished is through our Recycling Opportunity Notice Program. Dedicated personnel are located at all Metropolitan Toronto's transfer stations and landfill sites to visually inspect randomly selected loads of incoming waste and identify any loads that contain a high concentration of a recyclable material. Upon identifying these loads, Recycling Opportunity Notices are completed and forwarded to both the hauler and generator of the loads. The generator is encouraged to recycle future loads of the material, and is assisted in locating markets.

This program is primarily based on voluntary participation by the waste generators. However, it does provide some of the rationale for implementing mandatory measures, such as banning of specific materials.

After about one year of operating the Recycling Opportunity Notice program, it became apparent that one of the most common materials received at the landfill sites and transfer stations was corrugated cardboard. Many firms refused to recycle the material on a voluntary basis, citing problems such as lack of manpower and limited storage space. This led Metropolitan Toronto to implement a ban on corrugated cardboard. Since February 1, 1989, all loads containing more than 50 per cent. by volume of recyclable corrugated cardboard have been prohibited from all Metropolitan disposal facilities. Metropolitan Council has directed that this be reduced to all loads with over 20 per cent at all sites by September 1, 1989.

In order to enforce the cardboard ban, Metropolitan Toronto is using its existing enforcement method of issuing Violation Notices to the haulers of the material. If a hauler receives three violation notices for the same offence at the same site, the hauler is temporarily suspended from using the facility. During the first four months of the ban, over 250 violation notices have been issued. We project that the ban could divert 75,000 tonnes of cardboard per year, when fully implemented. Banning of other materials is also being considered. Materials which have alternative markets and can easily be separated from the waste stream will be considered for a ban.

Office paper is another material which has been targeted for diversion by Metropolitan Toronto. Planning statistics indicate that over 350,000 employees work in office buildings in Metropolitan Toronto. This is equivalent to about 35 per cent. of the workforce. One full-time Metro staff member will be working with businesses to implement office paper recovery programs. A second full-time staff member is developing programs for Metropolitan Toronto's own offices. As well, an office paper recovery guide is currently in production. This guide will provide business with a practical approach to setting up an office paper recovery program.

Waste tires are bulky items which are also considered a high priority for diversion. Waste tires can be remanufactured for re-use, or recycled into new products such as automotive parts. We are currently reviewing a number of proposals for diversion of waste tires.

Wood waste also has several potential uses such as horticultural and agricultural applications and use as a fuel. Following the development of alternatives for materials such as tires and wood, these materials will be banned from Metropolitan Toronto facilities.

Organic waste is another material which has other potential uses. Metropolitan Toronto is currently developing plans to construct a 190 tonne/day prototype plant for composting of organic waste. The facility will accept waste from a small number of commercial and industrial locations in Metropolitan Toronto. It will be used to establish design criteria and operating and maintenance experience for future plants which will handle larger quantities. This plant is expected to be in operation by 1991.

In order to raise the level of awareness of industry, Metropolitan Toronto is developing an education and promotion campaign. Newspaper advertisements have already been placed in the major daily newspapers. Plans are currently being developed for posters which can be used by companies to promote their recycling programs. As well, information will be available through fact sheets, brochures and booklets such as our office paper recovery guide.

Changing attitudes towards waste management is fundamental in bringing about action. Industry must realize that they can no longer generate unlimited quantities of waste as a by-product of their business. Strategies must be developed to minimize the generation of waste. Adequate resources must be allocated to deal with waste in an environmentally acceptable manner.

This change in attitude is already becoming apparent. The Board of Trade of Metropolitan Toronto recently produced a Waste Management Code of Practice which provides the private sector with a set of principles and guidelines for implementing programs for waste reduction, re-use, recycling and recovery. This type of commitment and leadership represents a new era in commercial and industrial waste management.

The corporate commitment to responsible waste management must begin at the very top. In order to encourage senior management of private corporations to increase their waste reduction and recycling efforts, Metropolitan Toronto together with the Region of Peel, the Region of Waterloo and the City of Guelph, has produced a video entitled "Pulling Together". The video emphasizes the tremendous responsibility that industry has in dealing with our solid waste crisis. It also provides practical solutions by featuring three companies that have implemented comprehensive waste management programs. The video is available for loan or purchase. Metropolitan staff use the video when conducting waste audits, and also when giving presentations to various industrial and trade associations.

The recycling success stories as a result of Metropolitan Toronto's efforts are numerous. For example, Shopsy's Foods Ltd. used to throw away all of their corrugated cardboard. This firm is now recovering 6-8 tonnes of cardboard per week. Shopsy's is also implementing a program to recycle a significant quantity of waste plastic. As well, the firm is currently investigating whether liquid ingredients could be received in a returnable container rather than metal drums. Shopsy's has always recycled the majority of their food waste and will continue to look for new ways to cut down on other waste materials.

Boeing Canada is another firm which had developed creative solutions in solid waste management. Last summer Metropolitan Toronto issued about 30 Recycling Opportunity Notices to Boeing for the disposal of corrugated cardboard. Boeing is now recycling all corrugated cardboard as well as office paper and pop cans. The number of loads of waste being sent to landfill has been reduced by almost 50 percent. Boeing is now exploring the diversion of other materials such as plastics, wood and glass containers. As well, Boeing has taken their corporate responsibility one step further by providing their employees with information on recycling through displays and articles in employee newsletters. This firm can truly be considered a leader in the area of solid waste management.

These are just two examples of the innovative initiatives that have been implemented by industry. In Metropolitan Toronto, there are over 70,000 commercial and industrial establishments including retail outlets. A collective effort by these firms will make a difference.

The Provincial goal of 25 percent waste reduction by 1992, will only be met if business and industry implements comprehensive programs for waste reduction, re-use and recycling. Metropolitan Toronto will continue to expand its efforts to assist the private sector to make this goal a reality.

THIRTY-SIX ONTARIO WASTE MANAGEMENT CONFERENCE

Toronto Prince Hotel
June 11-14, 1989

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Van Wagner, Jodi
Tricil
89 The Queensway West
Mississauga, Ontario

Veel, Aivo
Ontario Waste Management Corp.
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Van Veen, Lucas
Tricil (Sarnia) Ltd.
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Warner, Ray
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Watson, R.
Domtar Chemicals Group
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Pte. Claire, Quebec
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Wells, Wally
M.M. Dillon Ltd.
47 Sheppard Ave. East
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Westerby, Geoff
Gartner Lee Ltd.
140 Renfrew Dr., Ste. 102
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Whitehead, Roy
Enviroclean
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Witko, Claus
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Quebec & Ontario Paper Co.
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Wilson, James D.
Dominion Bridge Co.
200 Ronson Drive, Suite 607
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Falconbridge Ltd.
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ADDENDUM

(See Index Page 25)

TOXIC REAL ESTATE: AN OVERVIEW

by

DIANNE SAXE, LL.B.

"The modern chemical industry and the problems engendered through the disposal of its byproducts, is, to a large extent, a creature of the twentieth century. Since the Second World War, hundreds of previously unknown chemicals have been created. The wastes produced have been dumped, sometimes openly and sometimes surreptitiously, at thousands of sites across the country. Belatedly it has been discovered that the waste products are polluting the air and water and pose a consequent threat to all life forms. Someone must pay to correct the problem, and the determination of who is essentially a political question to be decided in the legislative arena.[1]

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[1] The State of New York v. Schenectady Chemicals, Inc. 459 N.Y.S.2d 971 (Sup.1983)

THE ISSUES:

WHAT IS TOXIC REAL ESTATE?

An electro-plating company leases land from a related corporation and an individual. The electroplating company is purchased and closed down by a large international corporation. The Ministry then discovers that the site and plant are seriously contaminated with cyanide and metals from leaking pipes and from an old spill. Who is liable to clean it up: the purchaser? the electroplating company? the directors of the electroplating company? the landowners? How should the cost be allocated among them? Does it matter that the parties are already suing each other?

A developer of an upscale condominium project, on the shores of a rippling river, finds 110 old vats left by a leather company when it shut down in 1930. The vats contain mercury, lead and arsenic. Over the next ten years, increasing contamination is found, in the vats, in the soil, and in ground water. The government proposes that 25 000 cubic metres of contaminated soil be removed, and that five million gallons of contaminated ground water be treated to remove phenols and heavy metals, before the development can proceed. Must the developer do so? Can he claim compensation from anyone? Will his project still be financially attractive?

A small industry goes bankrupt. At the time of bankruptcy, it has several outstanding mortgages, including one to the Federal Business Development Bank, a Crown agent. The property is piled with drums and badly contaminated. Which assets will be used to pay creditors, and which, if any, to clean up the property? If the assets are insufficient, who will pay for the cleanup? Is the federal bank in a different position than the other creditors? Can the officers and directors of the bankrupt company be held personally responsible?

The Ministry decides to move in and clean up a contaminated site. As security for its cleanup expenses, it takes an assignment of the first mortgage. What are the potential liabilities of the Ministry? of the cleanup contractor?

A railway leases land to a lumber company. The lumber company has a spill, which it channels into a lagoon. Shortly afterwards, the lumber company assigns its lease. The new lessee fils in the lagoon. Years later, the lease expires. The land lies vacant and is then leased to a third company. The third company excavates through the former lagoon, exposing extensive contamination. Who must clean it up: the landlord? One, two or all three of the tenants? The Ministry, that knew of the burial of the lagoon and took no other steps? Are they liable to each other?

An industry buys a building and decides to expand it. During the excavation, the purchaser discovers a large area of soil contaminated with creosote. It spends $80,000 to dig up the contamination, to haul it away, and to buy replacement fill. Two creosote manufacturers once owned the property, but they have long since gone out of business. Can the current owner obtain compensation from anyone?

A farmer is offered 'clean fill' for a low area on his farm. The fill turns out to be construction rubble, containing drywall, wood and other contaminants, rendering the area a waste disposal site which is barred from use for 25 years. In addition, the rubble causes groundwater contamination and the risk of methane explosions. Has the farmer committed an offence? How can he prevent his whole farm from being classified as a waste disposal site? If he dies, can his children refuse to inherit the contaminated site?

WHAT MUST BE CLEANED UP?

Cleanup of contaminated property may be required by the Ministry of the Environment by order. The order may be addressed to the person who caused or permitted the discharge which caused the contamination.[2] Where contamination, for example of groundwater, is threatened because of existing conditions on a property, the current owner or occupier may be required to take any necessary preventative measures, whether or not s/he created the problem.[3]

Where waste has been illegally deposited on a property, the current owner or occupier may be required to remove the waste,[4] as may the person who established or operated the waste disposal site.[5]

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[2] the *Environmental Protection Act*, s.16; see also the *Pesticides Act* s. 23

[3] the *Environmental Protection Act*, s. 17

[4] the *Environmental Protection Act*, s. 41, 42

If no administrative order has been issued, there is no general obligation to clean up toxic real estate. However, owners and occupants of such property do so at their peril. For example:

> As environmental awareness grows, the property may become much more difficult to sell.
>
> If the contamination is not fully disclosed to any potential purchaser, the vendor may be liable to rescind any contract of sale and/or to pay damages for deceit.
>
> Wise lenders may be reluctant to accept the land as security, or may charge higher interest rates to compensate for the increased risk that the property may become worthless and/or for their potential liability to clean it up.
>
> If anyone is injured or hurt as a result of the contamination, the owner and occupant may be liable for substantial damages, whether or not they created the contamination.
>
> The owner and occupant may be liable for property damage or loss incurred by others, e.g. if contaminated groundwater or public apprehension reduces the resale value of neighbouring property.
>
> Municipalities may be reluctant to grant planning approvals, such as amendments to zoning bylaws, or even building permits, especially if the contamination may affect the proposed use, or if the proposed construction or use may endanger others or the environment.
>
> If a discharge of contaminants occurs, the owner or occupant, or any other person with charge, management and control of the property, may be liable to prosecution.

It is also possible for a person adversely affected by any contamination, such as a neighbour whose drinking water is threatened, to seek an injunction prohibiting further escapes of the contamination and requiring it to be remedied.

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[5] the *Environmental Protection Act* s. 24

HOW CLEAN IS CLEAN?

In January, 1989, the Ontario Ministry of the Environment adopted guidelines for the decommissioning and cleanup of former industrial sites. The guidelines are used by provincial and municipal authorities when industrial sites are shut down or redeveloped, as conditions of building permits and other administrative approvals, or as the foundation for administrative orders.

The guidelines suggest that all contaminants present at sites to be decommissioned should be cleaned up to their background levels. Above background levels of contaminants are to be permitted only if those levels can be shown to protect human health and the environment. In case of doubt, more stringent cleanups will be required.

Where cleanup criteria above background levels are proposed, they must be consistent with present and future uses of the site, and with adjacent land uses. More stringent cleanups are required for agricultural, residential and parkland redevelopment than for commercial or industrial uses.[6]

There are three means by which a person may establish that a particular, above-level of contaminant is sufficiently low to protect human health and the environment. First, acceptable levels of the contaminant may already be specified in regulations, standards, policies or guidelines adopted by the Ontario Ministry of the Environment. Acceptable limits are now set for more than 100 contaminants such as, ammonia, and lead.[7]

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[6] Typically, the level permitted for industrial uses is 10 times as high as for residential uses.

[7] Ontario Water Quality Objectives, 1984, Ontario Ministry of the Environment

If Ontario has not yet adopted criteria for a particular contaminant, the ministry may accept criteria developed in other jurisdictions, if the criteria were developed for the purpose proposed, using acceptable methods, and if, in the Ministry's opinion, the criteria are strict enough to protect human health and the environment.

Where no acceptable criteria exist, a landowner has the right to propose criteria for a specific site, taking into account the toxicology of the contaminants present, their mobility, their impact on possible future uses, their possible interaction and the physical characteristics of the site. Such criteria are difficult and expensive to develop and must be approved by the Ministry before use. For smaller sites, it may be less expensive to simply clean up to background levels.

WHO MUST PAY FOR THE CLEANUPS?

The parties potentially responsible for any cleanup fall into two main groups:

those responsible for the contaminant, and

those responsible for the site.

Among those responsible for the contaminant are:

the generator of the contaminant, including the person who created it and the person who arranged for its disposal or discharge;

any other person whose actions were responsible for the discharge of the contaminant;

the person who transported the contaminant to the site of contamination;

the owner of the contaminant;

the person who had charge, management and control of the contaminant when it contaminated the land.

Among those responsible for the land are:

the person who had management and control of the land when it became contaminated;

the person who owned the land when it became contaminated;

the current owner(s) of the land, which may include

purchasers with knowledge of the contamination;

"innocent landowners" , who acquire the land with no knowledge, or reasonable means of knowledge of its contamination

those who acquire land through inheritance

owners of last resort, such as municipalities who acquire ownership through failure to pay taxes, or the Crown which acquires land through escheat;

lenders who acquire possession and/or title through foreclosing on a security; and

Fiduciaries, such as trustees in bankruptcy and receivers

One person may fall within more than one category. In addition, more than one person may fall within each category. For example, where a corporation is liable for having arranged the disposal of waste, its officers, directors and employees may similarly be liable.

If none of the above can be made to pay for cleanup of a problem which cannot be allowed to remain, it is the general taxpayer who will foot the bill.

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